AMATEUR ROBOTICS · MICROCONTROLLERS · COMPUTER CONTROL · ELECTRONICS Q&A

Nuts & Volts

September 2000
Vol. 21 No. 9

Exploring Electronics And Technology For A New Millennium

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Hexapod II From Lynxmotion At This Year's GEAR Robot Rendezvous

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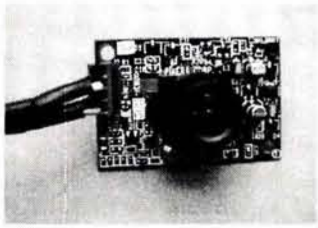
- Uses 4 - 5 VDC, only 150 mA! Three AA batteries would power it for over six hours!
- New in OEM pkg. (no box), 90-day HSC warranty



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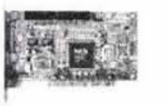

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- These were sold with Hewlett Packard S-700 UNIX workstations for videoconference capability
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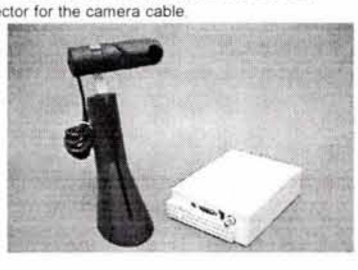
- We have technical data sheets for the camera. A condensed information sheet is included with camera pinouts and basic specs. Full specification document (camera only) available for $2.00 (cost of printing)
- The camera is on a weighted stand that extends from 13" tall to over 20" tall
- Color camera is digital output only (not NTSC as was previously believed)
- Note: HP and Logitech will provide no information on these items!
- Interface box has two SCSI-II ports on back, and a DC power input (we do not have the adapter), and on the front it has a mic. out jack, composite video input (BNC), and the connector for the camera cable.
- Units are new!

Now! Some technical data is available (Camera only)!



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Contents

VOLUME 21 • NO. 9 • SEPTEMBER 2000

Page 87

Page 5

columns ...

Classified Ad Index

Departments

articles ...

Meet our Design Contest
1st Place Winner
"WORLD PEACE"

Lots of details on Pages 48-49!!

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CLEARING UP TV RECEPTION AFLOAT

by Gordon West

There is plenty that you can do to improve your existing television reception down at the anchorage, or out on the water.

Does your dockside TV reception from local stations give you nothing but ghosts? Is your portable dish at the dock regularly leading to frozen pictures? Is there an annoying white line which continuously goes from top to bottom clouding up your picture? If so, tune into radio expert Gordon West's tips for improving your reception aboard ...

There is plenty that you can do to improve your existing television reception down at the anchorage, or out on the water. Some less expensive, over-the-air antennas may work better than real fancy ones when you are at the dock. And did you hear that high-definition television is coming soon, and you don't necessarily need to sign up for a satellite system either? And if you are on satellite, have you heard about the new in-motion antennas that can keep the kids tuned in, even in heavy seas? Read on! I'll have a much clearer picture for you.

12 VOLT TVs

Unless you are aboard a mega-yacht, I suggest a small boat installation start off with a 12-volt DC, 9-inch or 13-inch television. If you try to run a small AC-only television with a mobile inverter that changes 12 volts to 110 VAC, you will constantly be troubled by interference from that inverter that may show up as horizontal hash marks that travel from top to bottom on your TV set. The reason for the interference is the design of inverter DC-to-AC "switcher" transistor circuits. The new type of inverters most certainly scale down the inverter physical size and up their rated capacity, but the new generation of inverters generate a harsh wave form that disturbs over-the-air TV reception with these annoying interference lines.

For the last five years, television manufacturers may offer their portable color TVs with house power, as well as 12-volt direct current capabilities, built in. Two power cords: one for the house, and a red and black one for automobile or marine use.

And while you are at it, why not shop for a portable 12-volt DC color TV with a built-in VCR? If you should drop hook in an area with absolutely no local reception nor a view of the sky for satellite reception, videotapes will give you hours of enjoyment. Pricing for a 9-inch color combo AC/DC TV with built-in VCR was seen as low as $250.00 for a Phillips Magnavox portable set. Just be sure to look for the specific feature of AC/DC operation.


The in-motion large size KVH satellite antenna.


Flat-panel satellite antenna. Performance was excellent!

I would not be overly concerned that a new television purchased today with "just" analog reception will all of a sudden be obsolete tomorrow when regular TV signals go off the air in favor of digital, high-scan-rate, high-definition broadcasts (HDTV). The Federal Communications Commission (FCC) is sensitive to the number of regular TV owners in the United States, and will not all of a sudden force analog TV transmissions off the air within the next few years. About the soonest we may be seeing a switch from local

The flat-panel direct broadcast satellite antenna did nearly as well as the dish shown here.

broadcast analog TV to local broadcast digital TV would be 2006; and if that date holds firm — which I truly doubt — there will be hundreds of add-on boxes that would turn your regular shipboard analog TV into a digital TV receiver — just like the present boxes that take digital satellite signals and present them easily on your color analog TV set over TV Channel 3.

Your local mega-watt TV transmitters operate free (with commercials) to you on the following channels and frequencies:

TV Channels 2 and 3
54 MHz to 72 MHz
TV Channels 4, 5 & 6
76 MHz to 88 MHz
FM stereo music
88 MHz to 108 MHz
TV Channels 7 to 13
174 MHz to 216 MHz
UHF TV Channels 14-88
512 MHz to 806 MHz
New local HD digital TV
512 MHz to 806 MHz
Direct broadcast satellite TV
1500 MHz

To receive local (we will call them terrestrial) TV signals, your present onboard television has a low and high VHF built-in tuner for Channels 2 through 13, and an additional built-in UHF tuner for local Channels 14 through 88. If you haven't looked through the local channels lately on UHF, you should do so! Many times remote areas of cruising are served by television translator signals only found on these UHF channels. You probably thought there was nothing on UHF outside of your local cruising area, but indeed you may find your hometown big television station on the air over one of the UHF translator stations. Take a look at all you can get on UHF today when you are well away from your local port.

LOCAL RECEPTION ANTENNAS

Big white round antennas and small white round antennas are what we find for omnidirectional over-the-air TV reception aboard boats. These antenna systems usually have a built-in preamplifier, and voltage to run the preamplifier is sent up the same coax that downloads the VHF and UHF local transmitter signals. Some of these omnidirectional white antennas may also split out an additional coax cable for FM music reception on your little stereo unit aboard. However, for best FM stereo reception out on the water, I always recommend a common automobile antenna stashed somewhere, below decks, vertically polarized. If you want the ultimate in AM/FM reception, Shakespeare Antenna Group makes some dandy white fiberglass AM/FM reception sticks.

These omnidirectional marine antennas may present a more strong picture than a set of rabbit ears down below, but the down side is their inherent susceptibility to multi-path ghosting when you are at the dock. If all you get is a collage of colors and multiple images on your omnidirectional antenna, I would say that this is perfectly normal down at the big marina. The omni antennas are simply overdoing their job by picking up second, third, and fourth bounced signals from nearby buildings and nearby sailboat masts. These come in slightly delayed from the main picture, and this is why you get ghosts. There is no easy way to minimize ghosts down at the marina with an omni antenna. Omnidirectional antennas work best when out at sea, or at an anchorage with little around you to reflect the TV signal coming in multipath and delayed.

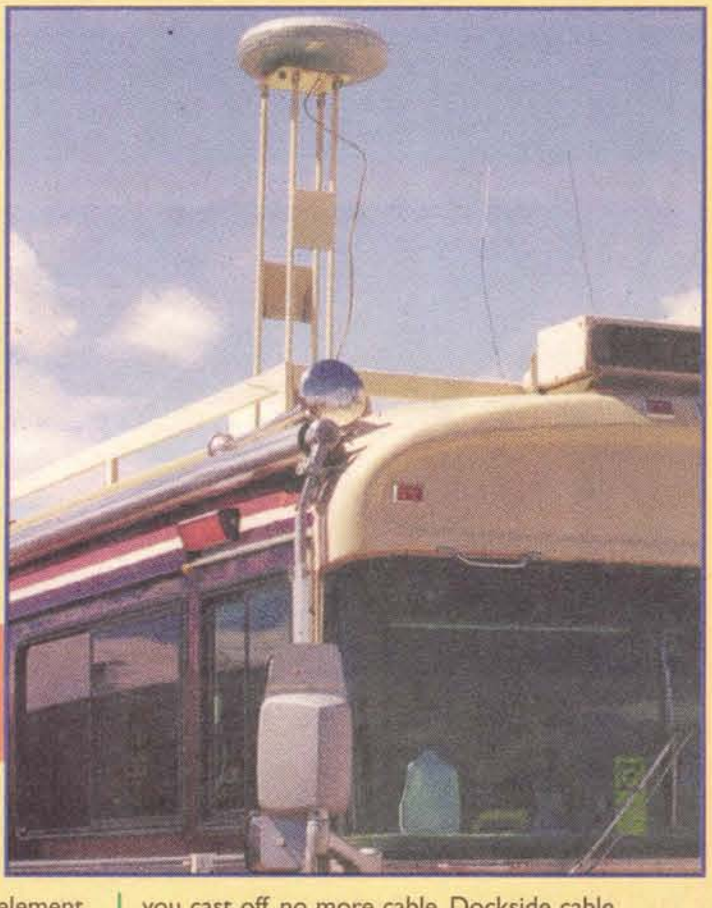
Down at the dock, you would probably do better to go down to your local RadioShack store and invest in a little five-element VHF/UHF beam TV antenna. This will dramatically improve picture reception, and will dramatically decrease ghosting. When you are ready to take the cruise, fold up the directional antenna, and keep it out of the weather down below. It has done its job down at the dock.

During recent tests of omnidirectional marine television antennas, they all worked relatively well out in the harbor, and they all suffered from ghosting in close to the marina. The very small omnidirectional antennas, resembling one of those flying saucers you throw to a friend, had good reception on the higher VHF channels, but didn't do very well on lower TV Channels 2 through 5. It takes a much larger omnidirectional antenna to pull in these lower channels, and we found terrific reception from the larger Shakespeare omnidirectional antennas, as well as those from Naval. Try to mount the antenna as high as possible from any other metals around your boat, then carefully wire in the little control box to 12 volts DC, and then make absolutely sure which end of the coax goes to the antenna, and which end of the coax goes to your TV set. Since that little black cube carries voltage for the antenna preamplifier, getting your leads mixed up and running coax with voltage on it to the television might mean an instant TV set burn out. Be careful here!

Shakespeare also makes a directional TV antenna enclosed in a small white dome. We tested this and found that it helps minimize ghosting. The directional Shakespeare antenna works off of a wired remote or even an infrared wireless remote, and the only disadvantage is you need to make adjustments at anchor when your boat swings on the hook. But the relatively new Shakespeare directional antenna does a nice job of minimizing ghosting down at the docks.

CABLE TELEVISION

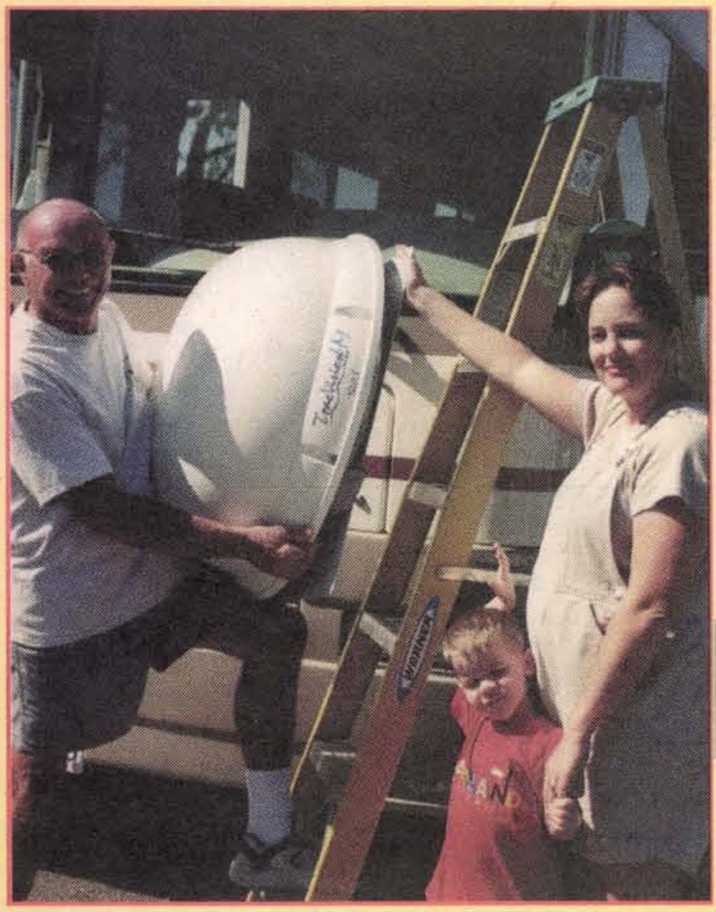
Cable works great at the dock. When you cast off, no more cable. Dockside cable reception is sometimes "fuzzy" due to salt air continuously eating up the cable connections.



Elevated amplified omni TV antenna.

SATELLITE TV RECEPTION

You might consider this as wireless cable reception, minus the cable. You add satellite television capabilities to your present analog AC/DC TV by subscribing to one of two satellite networks. One satellite network is called DirecTV, and the



other is the Dish Network. You would normally subscribe to one, not both, because each system requires its own unique receiver.

The proprietary receiver converts satellite digital signals into analog TV output signals that feed directly to your regular TV set "F" antenna connector. The satellite box has an outside antenna connector so you can switch between over-the-air TV reception from your amplified white omni antenna and then to direct satellite reception that you get with your dish or flat-panel aimed at the geostationary satellites.

But here comes the problem — most satellite receivers may only run on 110 VAC house power, so dust off that 300-watt inverter and put it to good use supplying house power to your satellite box for direct broadcast satellite reception. Luckily, direct broadcast satellite reception is unaffected by inverter hash, so you will get a nice clean picture as long as your TV jumper cables are nice and tight, and dressed as far away from the actual inverter as possible.

Incidentally, popular inverters like Heart, Trace, and Statpower will soon carry the Xantrex name exclusively in that all three companies have now been bought up by the Xantrex Corporation in British Columbia.

Your new direct broadcast satellite receiver takes coaxial cable to an externally mounted dish or flat panel that needs to be pointed squarely at the geosynchronous satellite. The dish or flat-panel concentrates the flea-powered satellite signal into a low-noise amplifier/down-converter seen on the end of the little arm on dish antennas that sits in the front of the dish. In the flat-panel antenna system, the down-converter is micro-strip circuitry within the flat-panel with no white wand in front.

Voltage from your new satellite receiver is fed up the same coax that is pulling the signal in from the satellite, giving power to everything on the inside of that little wand on the dish or inside the flat-panel antenna system.

Once again, make absolutely sure you never get mixed up on what connection is going from the satellite box to the TV, and what connection is going from the satellite box to the external antenna. If you should get these two common-looking leads mixed up, you put direct current on the TV input, and this puts you off the air for good until you take the TV in and get it repaired. Don't get these connections backwards.

The decision on what system to purchase is going to be a mighty tough one — both the Dish Network, as well as DirecTV offer tempting $29.95 program packages, comparable to what you would get at home with a $29.95 cable hook-up. Movie channels will cost you an additional $10-$20 a month, and so will the reception of a block of sports channels.

Good news for boaters in any area of the USA — the reception of local network affiliates like ABC, CBS, Fox, and NBC are now allowed by the FCC through our satellite system. Up until last year, many boaters not wanting to miss their local programming down at the marina had to sign up for satellite service at their aged grandmother's house, with a street address somewhere in the hills of Wyoming, outside of local TV coverage.

KVH in motion direct broadcast satellite antenna going from RV to boat.

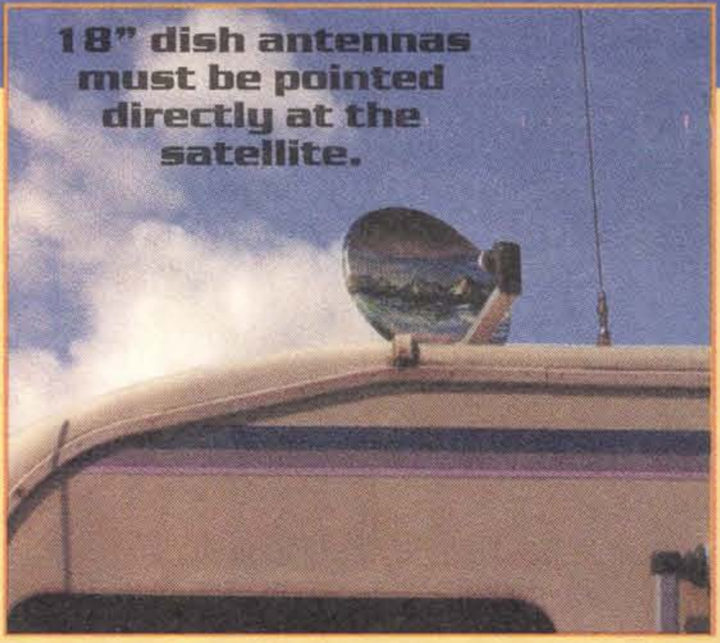
Write in 186 on Reader Service Card.

Even though you explained to your television service provider that you would be viewing TV well away from your local port, they would not sign you up because of legal restraints from local TV broadcasters not wanting to miss any of their local audience. No more problems now — for about $5.00 extra a month, you get East Coast and West Coast network coverage. If you don't like staying up late for Letterman or Leno on the West Coast, you can watch it three hours earlier from the East Coast feed!

But what are you going to do for pay-per-view when you are out at anchor and you just discovered a movie that you and the kids really wouldn't want to miss, and are happy to pay for? Since you're out on the boat, you don't have a telephone that hooks into your TV box, so you can't tell your box via the remote control to beam you down a pay-per-view movie.

What you must do is call the Dish Network or DirecTV on the phone, and speak with a customer service agent via your cellular or VHF radiotelephone and explain to them you want to sign up for a specific movie. This may cost you a couple of extra bucks, but it *can* be done.

So how can your receiver know what you paid for and what they won't allow you to see for your basic monthly price? This is the job of that special card that inserts in the receiver when you first buy it that allows for the reception of the channels you have paid for with your monthly assessment. This card is actually a miniaturized, integrated circuit that is constantly getting updates by your satellite reception. The card controls what you can receive off of the satellite, and the satellite controls what the card will allow you to watch. If you miss a payment, the satellite is continuously sending down an imbedded digital code of overdue accounts, and a blank screen with a message, "Please call customer service," greets you.


18" dish antennas must be pointed directly at the satellite.

Swapping cards with a buddy won't work — each card only works with a specific receiver that it is electronically programmed to over the satellite airwaves. Trying to buy phony cards that will fool the receiver that you have paid for everything usually leads to failure after a few seconds of receiver box turn-on. Direct broadcast satellite providers regularly send down electronic counter-measures (ECM data bursts) to render bootleg cards useless within seconds. Lots of people have tried to get around these ECMs, but it's a daily battle with the satellite providers always winning out.

Simply subscribe to the service like everyone else when you buy your equipment. Recent equipment promos by both Dish, as well as DirecTV, may allow you to acquire the receiver and antenna for almost free as long as you sign up ahead of time for one of their yearly premium packages. So shop around and get the most for your viewing enjoyment.

ONBOARD ANTENNA SYSTEMS

The television signals coming from TV satel-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KVH TracVision Cruiser is New, Low-cost Solution to In-motion Satellite Television for Boats

Many boaters have discovered that high-powered satellite television systems like DIRECTV®, USSB®, and DISH™ Network offer the perfect solution to getting good onboard reception and quality entertainment. Digital broadcasts deliver as many as 175 crystal-clear channels of news, sports, movies, and weather, as well as several dozen channels of commercial-free CD-quality music, as far as 100 miles off the coast of the continental United States. The challenge facing boaters is to keep their satellite antenna aimed with the necessary one degree of precision required to receive signals from the satellite. While not terribly hard when tied to the dock, it is extremely difficult to maintain that precision while swinging at anchor and nearly impossible while underway. Now, KVH Industries introduces TracVision® Cruiser, the new low-cost solution to the in-motion challenge.

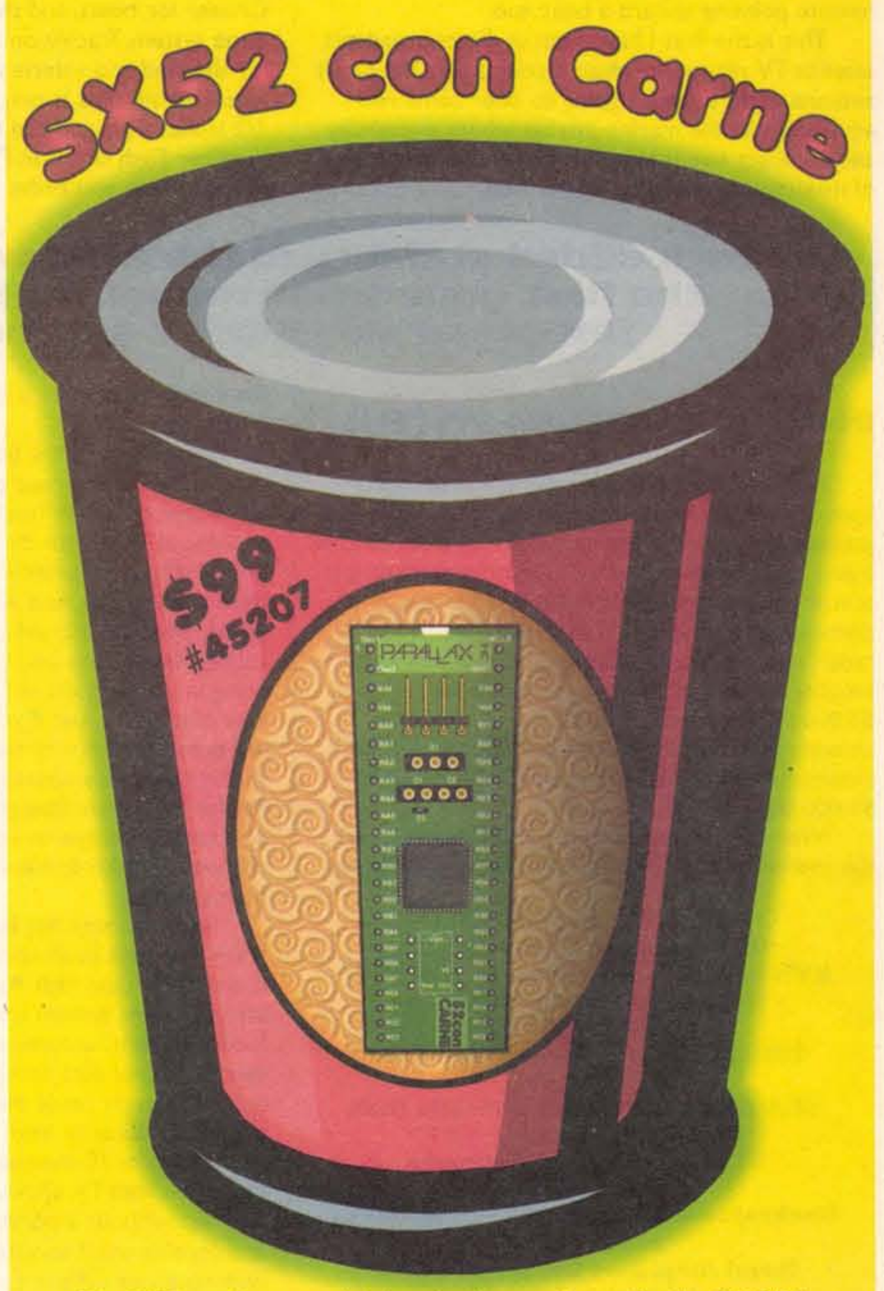
TracVision Cruiser is a gyro-stabilized antenna that accurately tracks television satellites, even while the vessel is underway in open seas. TracVision Cruiser measures only 14-1/2 inches high by 31 inches in diameter, and has a suggested retail price of $3,495.00, providing boaters the lowest profile, lowest cost, in-motion satellite television antenna available for marine use.

Using the same proven stabilization technology found in the rest of KVH's award-winning TracVision product line, TracVision Cruiser provides dynamic satellite tracking, auto-acquisition, reacquisition, and access to such popular satellite TV services as DIRECTV, USSB, and the DISH Network. The system is self-contained, with all of its components inside the easy-to-install, flush-mount antenna dome. The complete system weighs less than 35 pounds and can be installed in approximately four hours on most vessels.

"TracVision Cruiser provides a new level of flexibility and variety to the marine market," explains Jim Dodez, vice president of marketing and sales support. "Its low profile dome looks great on boats with hardtops. Thanks to our high volumes, we're able to offer this product with a retail price $1,500.00 less than similar in-motion systems."

KVH makes more in-motion satellite systems than any other company in the world, so the company is able to offer both high quality and low prices. The TracVision Cruiser is backed by a two-year parts, one-year labor warranty. KVH provides one of the most extensive support networks in the marine industry, with more than 200 dealers in the US and hundreds more worldwide. The company's manufacturing facilities have been certified to meet ISO 9001 quality standards.

In both 1998 and 1999, the dealers of the National Marine Electronics Association honored KVH with four "Best Product Awards," including those for best satellite television and best satellite communications systems. The company manufactures and markets digital navigation systems and mobile satellite communication products for use in commercial, military, and marine applications.



The SX52 con Carne module is a development board for the SX48/52 microcontrollers intended for use with the Parallax SX-Key development tools. Prototyping with TQFP and PQFP package styles of the SX48/52 just got easier! Available in a 48-pin DIP package at $99.

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lites blanket the United States with enough signal strength from either Dish or DirecTV to provide you with easily captured crystal-clear television programming with a little 18-inch parabolic reflector or a little 12-inch flat-panel phased array.

You can get TV reception throughout all of the United States up to about 100 miles offshore. This includes "fringe area" reception in the Bahamas, Baja, CA, and a little bit into Canada. The satellite TV transponders use spot beams to specifically illuminate all of the USA, and these spot beams at microwave frequencies are so precise that TV viewing more than 100 miles offshore or into foreign waters will usually abruptly stop. Keep in mind that these signals are coming in from geosynchronous satellites 22,500 miles away. The satellites rotate with us as the world turns, appearing motionless in their geosynchronous satellite orbit to our south and an uplook angle of 45 degrees or less.

If you plan to go boating in Canada or deep down in Mexico, there are other direct satellite providers that have satellites in orbit with spot beams to illuminate their foreign country. A compass will help you get your antenna bearings, following the instructions on the screen for a zip code reference on where you are, and on-screen suggestions on where to point. The DirecTV satellite is at the 101-degree west position, and the Dish satellite is at the 119-degree satellite slot, with both companies having additional satellites and slots for expanded service.

A dish or flat-panel antenna system would generally not work aboard a boat in anything but a calm-harbor, at-dock installation. If you have a small boat, it's best to position the dish on a dock piling and enjoy great reception at the dock. If you have a small boat and you plan to take your satellite system with you out on the water, you probably won't get any continuous reception of a picture until you take the antenna ashore, and plant it firmly in the sand. Even dockside installations are problematic when someone else is walking on the dock, and your antenna begins to sway back and forth. It will instantly lose track of the satellite. Go for the concrete dock piling as my best suggestion.

On larger vessels that don't rock when passengers come onboard, dockside TV reception is indeed quite possible to the satellite providers. Just as long as there is no major movement of the vessel, TV signals should stay locked on strong.

I recently tested the phased-array, flat-panel, marine TV antenna system from SATCOM, and it was a remarkable performer which uses the same technology in phased-array marine radar antennas as it does for direct-broadcast satellite TV reception. The flat-panel doesn't have quite as much gain as a dish, but this actually makes aiming the antenna easier in marine installations, especially aboard boats where there may be a little vessel movement. Even with a little vessel movement, the flat-panel antenna system held onto the picture without picture freeze frame. The phased-array flat-panel contains its own built-in LNB, and stores flat for taking it off the boat and putting it on your RV or out in the patio for home reception. It even comes with a digital signal strength meter for locking onto the distant satellite, and touching up any azimuth or element aiming. Our unit came with several different types of mounting brackets, and they are even working on a motorized bracket for

remote pointing aboard a boat, too.

This is the first I have seen in direct broadcast satellite TV reception when it comes to a flat-panel antenna, and I think it's going to offer some real advantages in the marine market where portability and compact size is important, plus the advantage of making aiming slightly less critical.

The rock added stability in the wind with the first generation mount for the flat-panel satellite TV antenna.

IN-MOTION ANTENNA SYSTEMS

For the first five years, several manufacturers have offered in-motion marine and RV satellite antenna systems. The popular Daytron DBS-4000 is a good example of a quality in-motion antenna system. It has a white radome that is 33 inches in diameter, and 15 inches high, looking much like a radar antenna, but containing an active moving satellite antenna on the inside. It sells for under $6,000.00. SeaTel also offers several in-motion antenna systems including a new 20-inch domed automatic-tracking antenna to be sold for under $5,000.00.

Well-known manufacturer KVH also entered the market with TracVision II which was a fully stabilized antenna dome of just 21 inches high by 19 inches in diameter, with an inside active antenna system locking onto the television satellite while in heavy seas or rolling at anchor.

DirecTV, 1-800-531-5000
Dish Network, 1-800-333-DISH
KVH In-Motion Antennas, 401-847-3327
Daytron In-Motion Antennas
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DBS Systems In-Motion Antennas
1-800-831-9818
SEA Sharp Automatic & Mobile Dish Antennas, 1-800-213-2211
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But these three companies did not want to miss the RV market, and KVH has broken the under-$3,000.00 mark by a 31-inch diameter x 14-inch high, 33-pound antenna called TracVision Cruiser for boats, and the same system, TracVision LM for the land and vehicle markets. This antenna is only 14-1/2 inches high, and can tune in either Dish or DirecTV service when you order it from your local marine electronics dealer.

Whether you are bouncing around on the road or on the water, the KVH TracVision antenna system with its low-profile design accurately holds onto the satellite. And when you're whizzing around out there, the antenna could also bring in 28 channels of CD-quality, interruption-free music, too. And if your vessel is all fiberglass, we even found during tests of the TracVision LM that it could also operate under a fiberglass shell, similar to its own fiberglass dome. This could give you satellite television reception without the low silhouette white dome showing off what you might have onboard.

So far, no one has been able to equal what KVH has done in an under-$3,000.00 package that is only 14 inches high. And also consider what this same antenna system could do for you in downloading extensive computer programs. Through satellite digital data compression, your same satellite TV antenna could download extensive web files in seconds directly from the satellite that would normally take 15 minutes through a telephone line. Microsoft web TV allows you to explore the Internet without a personal computer, and send and receive email and digital pictures on your TV with up to six different mailboxes. Kids could safely surf with "Kids Friendly"™ software that screens out unwanted material. Interactive video is a one-way fast download from your satellite, but you would still need a dockside or cellular land line phone connection in order to start things on the screen.

There is also TiVo that works off of your mobile marine satellite TV system, and you don't need any telephone outgoing connection to make it work. You can pause live TV, and then get back up to speed when you want, or create instant replays during live satellite broadcasts. This system will digitally record up to 30 hours of shows, and could automatically get your favorite recorded shows when you're not even aboard your boat. It takes a $400.00 Phillips receiver, but some of the benefits are seeing a great picture at a later time than when it was broadcast down from the satellite.

And how good is direct satellite reception on the water during our tests of the KVH TracVision low-profile system? For one thing, no ghosts, no snow, and superb audio — in stereo and surround sound, too. With the KVH system, there are no freeze-ups as our vessel is turning in the harbor, or swinging on the hook in the cove.

When compared to shore-side cable service, the satellite TV signal should look just as good, if not better. On very large onboard TV screens, you may see oversaturation between contrasting colors like a red blouse on a white background on satellite TV. Fast-moving action could also lose a bit of clarity if you have a keen eye on a major sized screen. So maybe direct-from-local transmitters will look a bit sharper, if you can make out the local terrestrial transmitter's signal through ghosts, hash, snow, and jiggles. You will have none of these problems with signals from the satellite, and the overall improvement from typical five-year-old home cable systems will be quite apparent.

You may count on the other big in-motion satellite manufacturers to try to equal what KVH has done with their newly designed TracVision Cruiser satellite TV antenna system. At under $3,000.00 — and portability to take it off the boat and put it on your motorhome — the KVH system certainly worked well for this writer. Next time you're down at the docks, check out TV reception when you spot one of those white TV motorized antennas. **NV**

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ELECTRONICS Q&A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist.
Feel free to participate with your questions, as well as comments and suggestions.
You can reach me at:
TJBYERS@aol.com
or by snail mail at
Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 92879.

What's Up:

Analog math circuits, new life for vintage radios, and a high-current motor speed controller. NiCd battery maintenance circuits, from proper care to rescues. Two PC solutions, and an RIAA update.

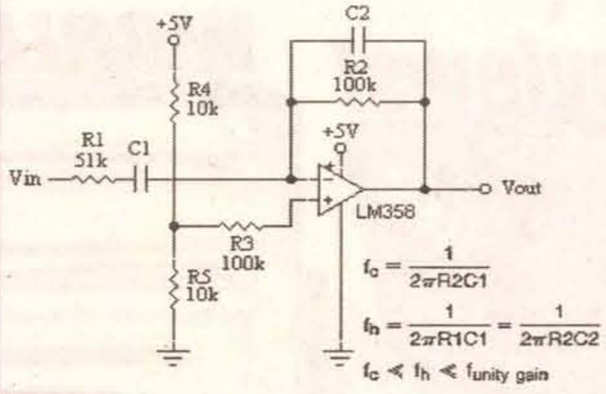
Issac Newton, Calculus, And Op Amps

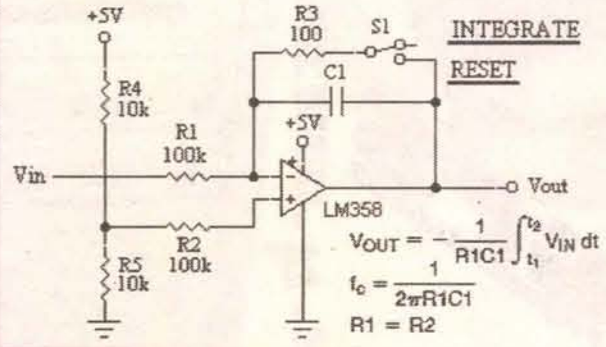
Q. I always thought it was interesting that you could perform differentiation and integration using an op amp. Could you show how to make both circuits accurately with a CA5160 or an LM358 op amp? I would like to interface the circuits to my microprocessor, then view the I/O results on the 'scope.

Keith Penner
via Internet

A. During WWII, derivative and integral functions using analog amplifiers were a critical part of the war effort. These analog computers were used to pinpoint artillery targets, map bombing raids, and sat at the very heart of the newly-invented RADAR. Described independently by Wilhelm Liebniz and Issac Newton in the 17th century, they were just a mathematical curiosity and mental exercise — until Newton recognized (in 1665) that the two are actually mirror images of each other (inverse functions) and could be applied to practical physics problems. As the physical world expanded from cannonballs to electrons, so did the applications for these two mathematical functions.

Here are two simple differentiator and integrator circuits that can be used to show what happens when a signal is processed by each.





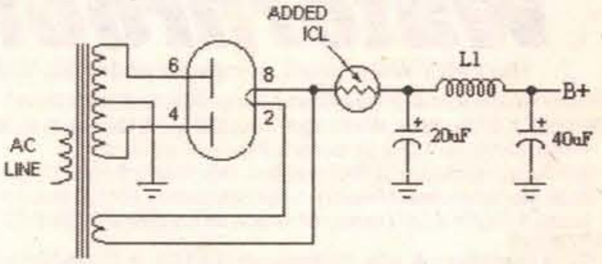
The differentiator works in real time, whereas the integrator takes a snapshot of an event and has to be reset by shorting out the capacitor. The resistance values shown are just ballpark values to bias the op amp into a linear region, and can be changed to match your frequency needs — just be careful that you don't set the gain too low (below unity) or too high (typically above 100). The equations are shown on the schematics.

Old Radio Breathes New Life

Q. I have a friend who has a Philco model 50-1721 radio (Sams photofact #98 folder) and he'd like to replace what he feels is a bad 5AZ4 rectifier tube with a solid-state rectifier. His question is what size resistor should be used between the solid-state rectifier and the input capacitor?

Mike Davoli
via Internet

A. This is an interesting question because of the age of the radio. An input resistor isn't normally required. But if the radio still sports the original electrolytics, they are used to a gradual voltage build up, and not a hard hit like what happens with a solid-state rectifier. While I can't say this would cause a problem, your friend is wise to take precautions. Instead of a resistor, though, I suggest an inrush current limiting (ICL) thermistor, like the KC014L-ND from **Digi-Key (1-800-344-4539; http://www.digikey.com)**. When the thermistor is cold, its resistance is 50 ohms, which dampens the initial charge current. As the thermistor warms up, its resistance decreases to about 10 ohms (dependent on the current flow), making it more power efficient than a fixed resistor. The ICL should be inserted into the circuit as shown.



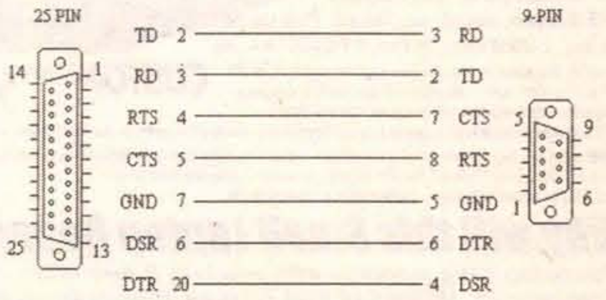
Some models of this series use an electromagnet speaker, so the circuit isn't typical of what other readers may find in their 5U4-equivalent power supplies. Consequently, I've modified the schematic to show the more popular configuration (the high-voltage center tap of the earlier Philco model 50 goes through the speaker's electromagnetic to ground).

Mac To PC Printer Cable

Q. I have an older Mac connected to an Apple Laserwriter II NTX which I rarely use any more. I'd like to connect the printer to my HP Pavilion, but I understand that the printer has to plug into the serial port, not the parallel printer port. What kind of connecting cable do I need? The printer is 25 pin and the PC serial port is 9 pin. How do I set up a COM port for the printer (I'm running Windows 98)?

Ken Schmidt
via Internet

A. What you need is a null modem cable, which you can buy for about $5.00. Unfortunately, finding one with the ends you need is a bit harder than null modem cables with identical plugs on each end. Fortunately, it's easy enough to make one using the drawing below.



Some sources (both books and articles) say that reversing the number 2 and 3 pins makes a null modem. That's not exactly true, as you can see. Printers, for example, need a full complement of communication signals.

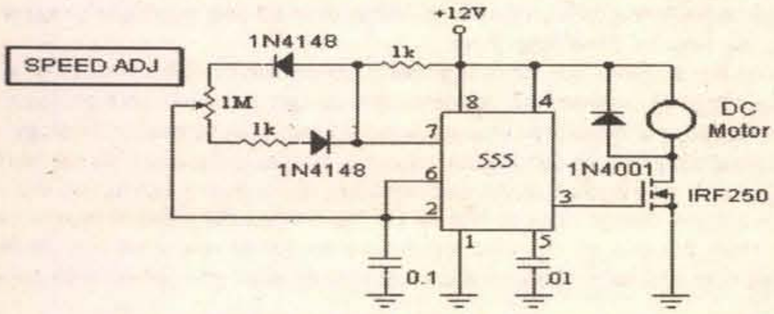
DC Motor Speed Controller

Q. I'm trying to convert a RadioShack "DC motor speed control kit" to drive a six-volt, 30-amp RC

car motor. The original circuit uses a 555 timer chip and a TIP122 bipolar transistor, rated 5 amps at 100 volts. I suspect this can be done using a MOSFET transistor, but I don't know how to generate the -4 volts needed to turn the MOSFET fully off. I think that most commercial speed controllers for RC car and airplane motors use MOSFETs, so there must be a way. As long as you're looking at the circuit, I was wondering how to increase the frequency of the switcher? My guess is reduce the value of the 0.47uF cap, but I haven't tried it yet. Also, how can I extend the duty rate range from 10% to 90% to more like 1% to 99%?

Pete Lawrence
via Internet

A - This is easily done using an enhancement-mode MOSFET, which is off with no gate voltage and turns on as the gate voltage is increased, instead of depletion-mode FET, which is on until a negative voltage is applied to the gate to turn the transistor off. The IRF540, available from **Digi-Key (1-800-344-4539; http://www.digikey.com)**, matches your needs exactly with 28 amps at 100 volts. Moreover, it needs only 10 volts to turn it fully on — with just .077 ohms at saturation.



Like your original circuit, this speed controller uses pulse-width modulation (PWM) to control the speed of the motor. When the duty cycle is low (25% or less) very little power is delivered to the motor and it spins slowly. As the duty cycle increases, do does the speed of the motor until 100% is reached, at which point the motor receives full voltage. You'll notice that I've increased the input voltage from 6 to 12 volts. This accomplishes two goals: First, it guarantees that the MOSFET turns on fully. Second, the extra voltage provides greater motor torque at lower speeds without damaging the motor at higher speeds (higher-than-specified voltages are often used in permanent magnet motors, particularly stepper motors, to improve low-end performance). The resistance and capacitance timing values are also changed from the original to give you a wider duty-cycle range (approximately 3% to 97%).

(Editor's note: Pete built this circuit using three IRF740 MOSFETs, 10 amps at 400 volts, in parallel and reports everything works fine. TJ)

I Want To Donate My Old PCs, But ...

Q - I have a bunch of old computers and brand new MFM hard disk drives that I want to get going for the senior citizens here. Is the hard disk protocol (RLL, MFM, or IDE) part of the motherboard, the add-on board, or what? Can you add MFM to a 386/486 system, for example? Also, can you mix and match in one system with the right ISA boards?

Chris Smith
via Interent

A - Hold on, this may be a bumpy ride. First, RLL and MFM refers to the type of coding used to put data on the hard disk platter. IDE is an interface type, not an encoding standard, that lets you plug hard disks of any coding type into a PC, and is often used to interface with CD-ROM and streaming tape drives; it's not exclusive to hard disks. Some PCs have an IDE interface built into the motherboard, others don't. All hard disks need a controller circuit that tells the read/write head where to be and where the data should be placed in that region of the platter. With IDE drives, this controller is built into the hard drive. The only thing the PC sees is the IDE interface. RLL and MFM hard disks, on the other hand, have their controller off the hard disk on a controller board that plugs into an ISA slot on the motherboard. To use an MFM drive, you must have both the drive itself and an external controller card. Same for RLL, which predates MFM and IDE. To reiterate, RLL and MFM drives require an external controller card. Both require two ribbon cables (a 20-pin and a 34-pin) from the controller card to the disk drive, and while seemingly identical, the two aren't interchangeable. IDE requires an interface connector, either via an (plug-in) adapter card or built into the motherboard. Simply plug the MFM controller card into an empty ISA slot, bring up the BIOS setup menu, and enter the drive type.

If your motherboard has a built-in IDE interface, and you want to use an MFM hard disk, you must disable the primary IDE interface using the CMOS setup and enter the parameters for the MFM drive. The CMOS setup menu

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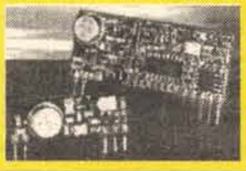

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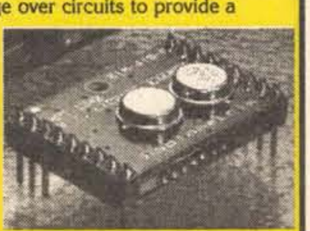

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can generally be brought on screen during boot up by pressing a combination of keys, typically Ctrl, ALT, Enter. Sometimes you can call up the CMOS menu after the PC has booted, but not always; it depends on the machine. After the menu is on screen, choose the drive type that most closely matches your MFM hard disk. You will need to know the number of cylinders, heads, and sectors. Here's a handy table that should answer all your CMOS questions for MFM drives.

Type	Cylinders	Heads	Sectors	Write Precomp	Loading Zone	Capacity
1	306	4	17	128	305	10 MB
2	615	4	17	300	615	20 MB
3	615	6	17	300	615	31 MB
4	940	8	17	512	940	62 MB
5	940	6	17	512	940	47 MB
6	615	4	17	65535	615	20 MB
7	462	8	17	256	511	31 MB
8	733	5	17	65535	733	30 MB
9	900	15	17	65535	901	112 MB
10	820	3	17	65535	820	20 MB
11	855	5	17	65535	855	35 MB
12	855	7	17	65535	855	50 MB
13	306	8	17	128	319	20 MB
14	733	7	17	65535	733	43 MB
16	612	4	17	0	663	20 MB
17	977	5	17	300	977	41 MB
18	977	7	17	65535	977	57 MB
19	1024	7	17	512	1023	60 MB
20	733	5	17	300	732	30 MB
21	733	7	17	300	732	43 MB
22	733	5	17	300	733	30 MB
23	306	4	17	0	336	10 MB
24	925	7	17	0	925	54 MB
25	925	9	17	65535	925	69 MB
26	754	7	17	754	754	44 MB
27	754	11	17	65535	754	69 MB
28	699	7	17	256	699	41 MB
29	823	10	17	65535	823	68 MB
30	918	7	17	918	918	53 MB
31	1024	11	17	65535	1024	94 MB
32	1024	15	17	65535	1024	128 MB
33	1024	5	17	1024	1024	43 MB
34	612	2	17	128	612	10 MB
35	1024	9	17	65535	1024	77 MB
36	1024	8	17	512	1024	68 MB
37	615	8	17	128	615	41 MB
38	987	3	17	987	987	25 MB
39	987	7	17	987	987	57 MB
40	820	6	17	820	820	41 MB
41	977	5	17	977	977	41 MB
42	981	5	17	981	981	41 MB
43	830	7	17	512	830	48 MB
44	830	10	17	65535	830	69 MB
45	917	15	17	65535	918	114 MB
46	1224	15	17	65535	1223	152 MB

If in doubt, enter type 20 — that's the IBM default for MFM (XT) drives. Can you mix types? Sure, but then you have to set jumpers on the drive itself so that the boot drive is the master and the second drive is the slave. You'll need to look up the drive type to see which jumpers to change, because they vary from one model to another. Most MFM controllers support two MFM drives, so you won't need an extra controller card.

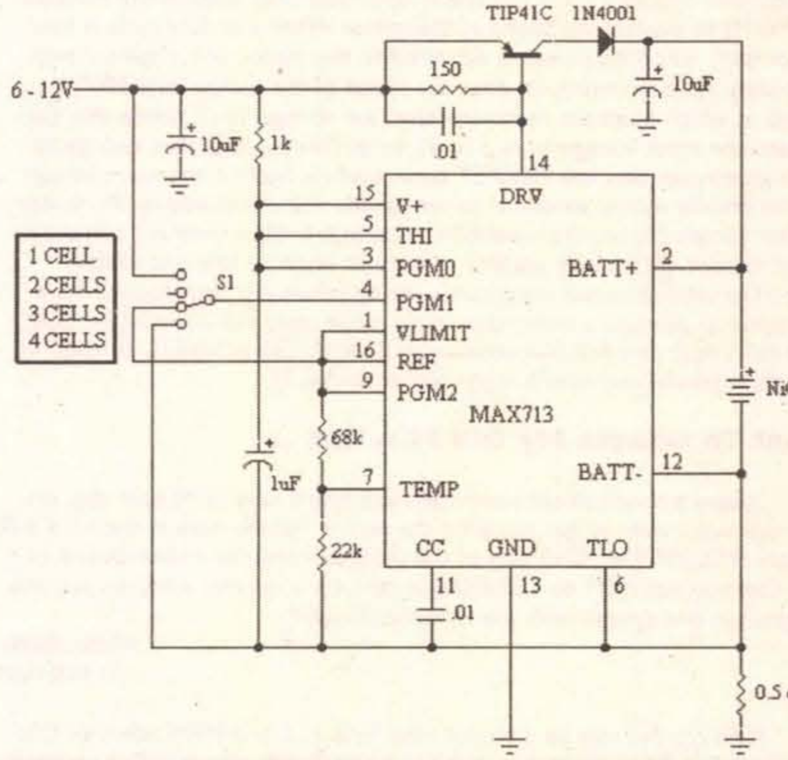
Modern NiCd Battery Charger

Q. Please tell me what issue the article "Recharging Dead Nicad Batteries" was in. I have searched through my past issues and have been unable to locate it.

Steve Andrews
via Internet

A. I can't locate an article by that title either. The closest I can come is an article in the Dec. '96 issue which uses technology that's more than four years old. This gives me an opportunity to update you and other readers about current NiCd technology. While the chemistry of the battery remains the same, current densities have increased by two to four fold and the new batteries are a lot more tolerant to overcharging and deep-discharge abuse. This lets you cram more power into the battery in a shorter period of time, which reduces the turn-around time. What used to take overnight to accomplish can now be done in an hour.

As the batteries got more aggressive, so did the chargers. Instead of a hodgepodge of individual components, the charger evolved into a compact IC with functions and features impossible to achieve with former technology. Accurate temperature sensing, for example, monitors the battery's temperature rise so that instead of the cell exploding like a cherry bomb, you can safely achieve charge rates as high as C4 (four times the rated discharge current rate). But enough chit-chat about how we got to where we are, you want to see nuts and volts. Here's a good example of what you can do with a modern IC.



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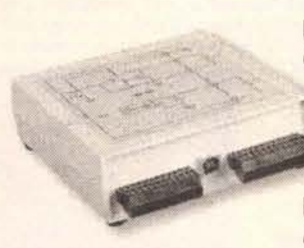

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Built around a Maxim MAX713 Fast-Charge Battery Controller (they don't call them battery chargers any more), this circuit can fully charge four "AA" cells in less than an hour. The MAX713, and its companion chip the MAX712 (for NiMH cells), can operate in either a linear or switching charge mode. The controller is always in one of two states: fast charge or trickle charge. In the fast charge mode, a constant current is forced through the battery. Once full charge is detected, the controller shifts to the trickle charge mode. The IC monitors three variables to determine when the battery reaches full charge: voltage slope, battery temperature, and charge time. For this design I've selected linear charge operation with voltage slope detection. As a NiCd reaches full charge, the battery voltage shifts from positive rising to slightly negative regression (cell voltage begins to decrease). When the MAX713 detects this negative voltage slope, it switches the controller into the trickle mode to prevent overcharging.

This circuit can charge up to four series cells at a time. Switch S1 selects the number of cells across the BATT+ (pin 2) and BATT- (pin 12) charging outputs. The fast-charge current is set to 500 mA by the 0.5-ohm resistor (R1), which is safe for most C, D, AA, and AA cells. For smaller capacity cells, reduce the fast-charge current by increasing the value of this resistor using the formula R1 = 0.25/I, where I is the maximum fast-charge current desired. (See the question below, "Novel NiCd Charger," for details on relative charge rates.)

Cool Web Sites

Driver Guide — http://www.driverguide.com
Let's face it, finding the right device driver can be a tedious, time consuming, often impossible task! The Driver Guide was created to make finding driver updates a whole lot easier.

Oscilloscope FAQ — http://people.ne.mediaone.net/wd1v/dsofaq.html
Both seasoned engineers and hobbyists alike can get a lot of useful information aabout oscilloscopes at the Oscilloscope FAQ site. The information was prepared by John Seney, a LeCroy Sales Engineer, but it is not an official LeCroy site. The site's content is based on Seney's approximately 20 years of experience as a test and measurement sales engineer. It contains a wealth of information for anyone using or buying oscilloscopes, including "The Top 10 Scope Mistakes," tips on comparing scope models and more.

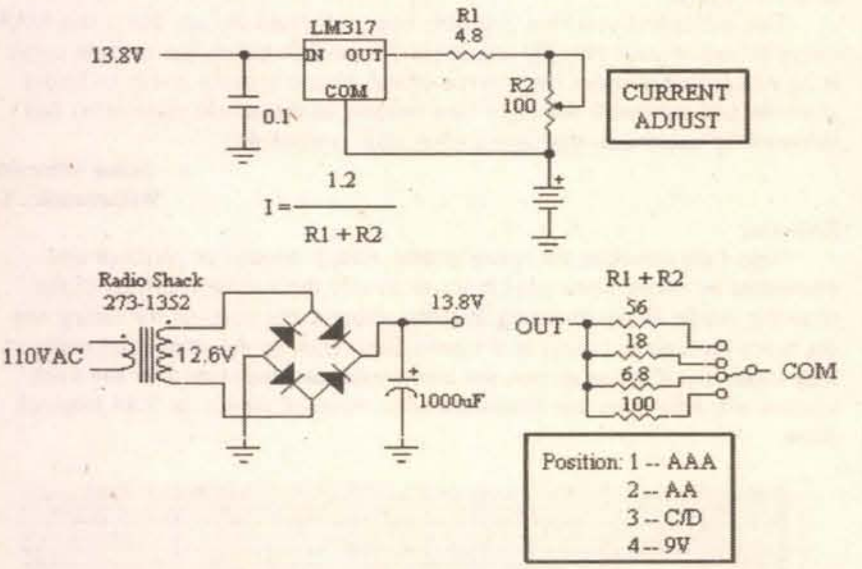
Muzique — http://www.muzique.com/index.html
Books on music projects, schematics of vintage guitar amps, and links to related sites.

Novel NiCd Charger

Q. For years, I have had great success restoring NiCd cells used in a variety of tools, toys, etc. Up 'til now, I've used a "CHART-CHARGE" Model 250-R variable mA NiCd charger (housed in a 3 x 6 x 2 plastic case). Yesterday, it went up in smoke. Do you know where I can get another or similar unit, or can you provide me with a circuit of a variable-rate, constant-current charger? The old one went from 0-250 mA with a calibrated dial on the front panel; no meter, but the numbers on the dial tracked the output current quite closely. I wish to continue to rejuvenate, resurrect, restore — or whatever you call it — my NiCd batteries. Any circuit you provide I'm sure would be just fine, as long as I can vary the the output current.

Robert W. Johnson W3RZR
Mount Airy, MD

A. It appears your deceased Chart-Charge unit is just that, long gone. But I think this circuit is a suitable substitue.



It's built around an LM317 adjustable voltage regulator configured as a constant-current source. The output current is calculated using the formula I = 1.2/R. The amount of current needed to refresh a cell depends on the capacity, or C (in milliamp hours, mAH), of the cell. As a rule, NiCd cells can handle a charge current of C/10 indefinitely without overcharging or damage — approximately 65 mA for a AA cell, for example. If you don't mind keeping an eye on the charger, a more aggressive C/3 charging current can replenish a cell in just four hours, after which the current must be reduced to C/10 or the cell removed from the charger. Here's a chart of typical charge currents.

Cell Size	mAH Rating	C/3 (mA)	R1 + R2	C/10 (mA)	R1 + R2
AAA	220	73	16.9	22	56
AA	650	217	5.6	65	18
AA (premium)	850	283	4.3	85	13.7
C	1800	600	2.0, 1W	180	6.8
C (premium)	2300	767	1.5, 1W	230	5.1
D	1800	600	2.0, 1W	180	6.8
D (premium)	4500	1500	0.8, 2W	450	2.7
9V	120	40	30	12	100

This charger can handle single cells and batteries (multiple cells) up to 12 volts, and the output current can be doubled from 250 mA to 500 mA by lowering the value of R1 to 2.4 ohms. R2 is an audio (log) taper potentiometer (TechAmerica 900-5892 or equiv.). To calibrate the dial, insert an DMM ammeter in line with a 10-ohm, 10-watt resistor (in place of a battery) and annotate the dial as you advance the current. However, the price of the pot is $16.25, so it may be more economical to replace R1 and R2 with fixed resis-

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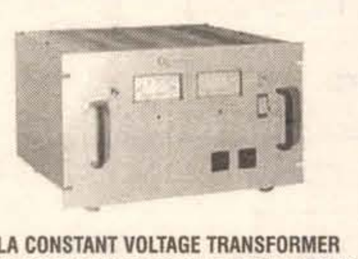
Stock #TE9812 $200.00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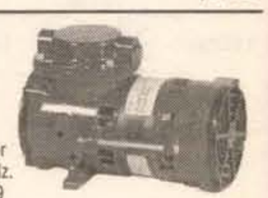
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tors and a rotary switch (RadioShack 275-1386), as shown in the schematic. The fixed resistors are 1/4 watt or 1/2 watt (above 210 mA) unless noted otherwise.

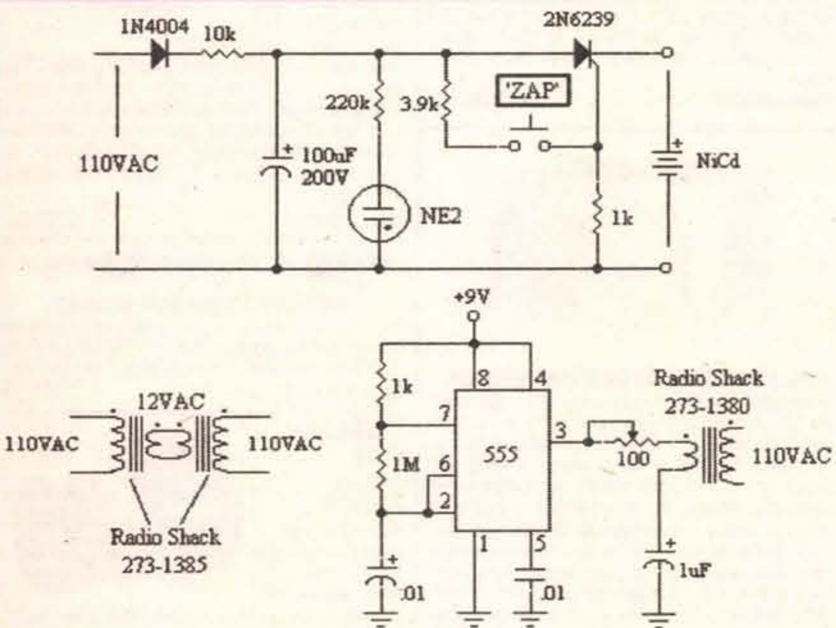
NiCd Zapper

Q - I've heard you can bring a dead NiCd battery back to life by zapping it with a high voltage. Is this true, and how is it done? I have a drawer full of NiCds, resting in peace, that I'd like to bring back from the dead.

Jim O'Neil
via Internet

A - All good things must come to an end, even the life of a robust NiCd rechargeable battery. There are two reasons why NiCd batteries fail. The most common is the result of a shorted cell. Every time a cell is charged, the active material is redeposited on the plates. Ideally, this occurs uniformly across the surface of the plate. In reality, there will be hills and dales, where there is a concentration of material in areas and less in others. When the hills on the negative match up with the hills on the positive plate, the resistance between them is less than adjacent areas, and the current density is greater. This gives rise to even more bumpiness because this region attracts more active material during recharge. Actually, the build-up grows like stalagmites needles in a cave and is called dendrites. In time, these needles force themselves through the insulating separator and shorts the two plates together, rendering the cell useless. A cell that appears to self-discharge in a couple of days has dendrite problems, and the cell will eventually short out. This is part of the natural aging process.

Zapping cells is a quick fix that removes the short and extends the battery's life. By forcing a large impulse of current through the cell, you can actually vaporize the dendrite — it's like blowing a fuse. However, it's only a stop-gap measure. The fact that one dendrite has formed means that others aren't far behind. Moreover, the vaporized material is now in the paste, which lowers it's resistance and leads to greater self-discharge. While the short may be gone, the cell will have less charge retention and go stale sooner. Eventually, all the active material will be used up (the second reason batteries fail) and no amount of zapping will bring it back. But hey, any life is better than none, so give it a zap!



LINE OPERATION **BATTERY OPERATED**

This circuit is a high-voltage NiCd battery zapper that uses the charge stored in a capacitor to vaporize the dendrite. The capacitor is charged through the 10k resistor to 160 volts. When the charge reaches about 100 volts, the neon lamp lights, indicating the zapper is ready for service. Pressing the Zap button turns on the SCR, and dumps the capacitor's charge into the NiCd battery. The zapper can either be line powered using two back-to-back transformers to provide isolation from the AC line, or battery powered. For battery operation, a free running 555 oscillator alternately charges and discharges a 1 uF capacitor in series with the primary winding (8 ohms) of an audio output transformer, where it's boosted to about 110VAC in the secondary. The 100-ohm pot adjusts the output voltage.

High Power Inverter Problems

Q - A friend, who uses wind power for his home, gave me his inverter to fix. It's made by Dytek Laboratories (out of business) and is about 10 years old. It takes 32 volts DC and converts it to 110VAC at 2200 kW. The unit has an 8-by-8-inch control board chock full of ICs, four banks of TO-3 transistors, two massive transformers, and other assorted smaller trasformers and drive transistors. None of the transistors appear bad and there are no burned components, but when I apply 32 volts to it, it only draws about one amp with no AC output. Any ideas as to where to start?

Jim Babcock
Jim.Babcock@Unisys.Com

A - This is a tuffy because I'm troubleshooting from afar. The fact that it's drawing power means something is alive inside the inverter, but it's certainly not the power section. My first guess is that the inverter is disabled via one of its many protection devices or by user command. Very often inverters in this power range will shut down if there's no load on the output. Try that first; put on a light bulb or something and make sure the manual override is engaged (if it has one). Next, I'd suspect the master oscillator. Even if the power section is disabled, the 60-Hz oscillator should be running. For that you'll need an oscilloscope. Beyond that, I'm at a loss without actual hands-on troubleshooting of the system. I'll include your email address and let's hope a reader has a schematic or knowledge of this unit.

MAILBAG

Dear TJ:

In response to your motorcycle spark detector circuit in the May 2000 issue, a small, portable AM radio works for me. Try it.

Andrew Poteete W4SQE
via Internet

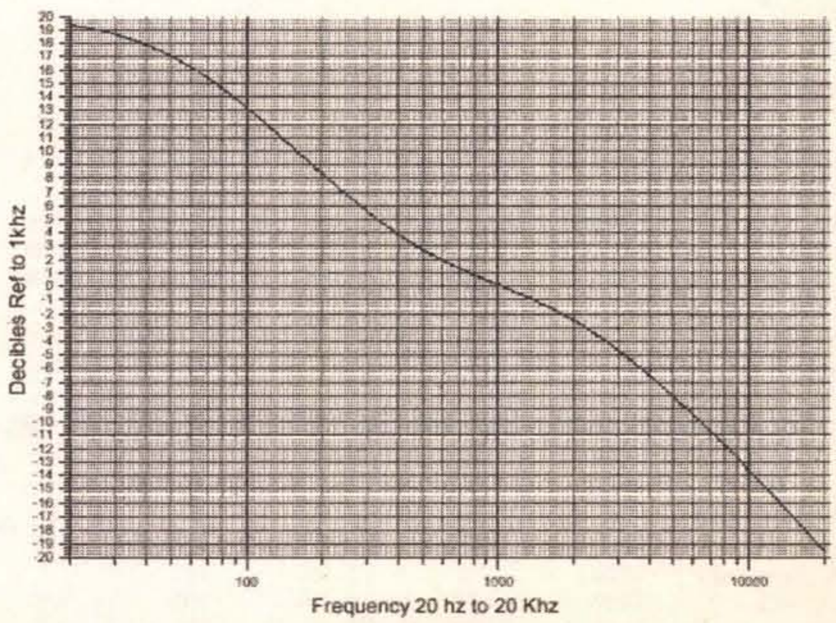
Dear Mr. Byers:

This is late and you have probably been informed already but ... the RIAA curve shown in your May '00 column is the encode curve. The decode curve is, as you probably know, the inverse of it. A phono preamp needs to boost the lows and attenuate the highs (the reverse of the article statement). You will note by inspection that that's what your circuits do.

John Schwenk
Willimantic, CT

Response:

Oops, I did download the wrong graphic. Bass is boosted on playback and attenuated on record. Know why? It has to do with the mass/acceleration of the recording needle. As the frequency increases, there is less travel on the cutting needle, hence the smaller the cut in the grove. Bass notes, on the other hand, make a wide swash and if left on its own, the base would consume more than one track, which is why base notes are attenuated when recorded. Here's the RIAA playback curve.



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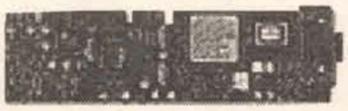

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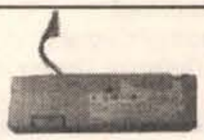

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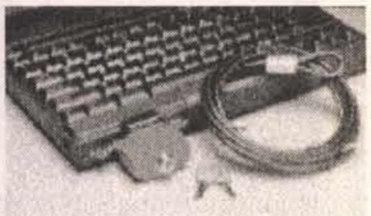

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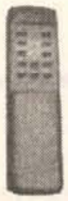

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Newsbytes

LONGEST RANGE CORDLESS PHONE SYSTEM AND TWO-WAY RADIO IN THE NATION.

With 70 million cordless phones in the US made by such big names as Lucent, Panasonic, and Sony you might not expect many new innovations, especially from a smaller company. Wrong! EnGenius Technologies, an award-winning leading provider of the longest-range cordless business phone system and two-way radio, announces the availability of the EnGenius™ SN-900 Ultra. EnGenius was the 2000 Consumer Electronics Show (CES) Workstyle Award winner, which is the ultimate honor for a new product. The EnGenius SN-900 Ultra accomplishes its longest distance competitive claim by providing the most power of any cordless phone, 630 milliwatts, which is much more than any other 900 MHz cordless phone or 2.4 GHz cordless phone. The SN-900 can be used at the extensive range of 11 floors in a building, 2,000 acres or 150,000 square feet in-building. The SN-900 is also the only two-way radio allowing handset-to-handset communication without going through the base unit or being near the base.

The EnGenius two-way radio is full duplex to allow users to listen and speak at the same time, something competitors do not offer. The phone system can expand, as the user's needs change, to a maximum of four telephone lines and 36 handsets to handle dynamic SOHO environments. The SN-900 model's digital spread spectrum frequency hopping technology is a military type digital security, which provides the most complete privacy available today. To ensure complete security and a clear signal, the SN-900 hops to different frequencies more than 200 times per second. Quality is also built-in by EnGenius Technologies' ISO 9001 certified factory.

The SN-900 provides many features in addition to the longest range available. These include call transfer capability, a call manager and smart auto power management so the phone only uses the power it needs to provide a good signal. This smart power-saving feature allows you to get up to four hours of talk time and 36 hours of standby time. Also featured is an SN-900 fast battery charger which fully recharges the battery in 90 minutes. If the battery runs low while talking to a caller, the battery can be changed by simply putting the caller on hold and slipping in another battery without losing the call. The SN-900 comes standard with two antennas — one low profile for convenience and one longer antenna for maximum range. Each handset includes a free leather carrying case, belt clip for easy carrying, and a second battery pack. Other features include Caller ID with call waiting, 30 preset number speed dialing, selectable voice and ringer volume with selectable ringer sound, low battery alarm and display, illuminated key pad, vibrate or ring mode, received signal strength indicator, three line LCD display, and selectable key sounds. The SN-900 is also hearing-aid compatible. The base unit, handset, spare battery, charger, two antennas, and leather carrying case with belt clip is priced at $299.00. Additional handsets with spare battery and charger are priced at $159.00.

EnGenius Technologies develops and markets EnGenius™, the industry's longest-range cordless phone and two-way radio system — currently available through 600 resellers, distributors, catalogs such as SkyMall, Hello Direct, Hammacher Schlemmer, and Topix, and superstores such as BrandsMart USA and Fry's Electronics.

For more information visit the **EnGenius Technologies** Web site at **www.engeniustech.com** or call **1-888-735-7888**.

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New models from Audiovox offer features like extended range (Model GMRS-1525 with five-mile range), FM stations, weather band access, new colors, and "hot" metallic finishes. There is something for everyone, from the mom who wants to stay in touch with the kids, to the hiking, skiing, and camping set who need to be in touch constantly."

The 500 Series consists of FR-500-2, FR-530-2, FR-540-2, FR-

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550WB, and FR-560FM-2. (The –2 denotes twin pack.) All models are ultra compact and feature power-save circuitry, fold-down antenna, swivel belt clip, and two-mile range. The FRS-560FM, 550WB, 540, and 530 offer built-in VOX, a feature that allows the user to start a transmission upon talking, hands free, no buttons or switches to activate. When the person stops talking these units automatically switch to the "Receive" mode.

All 500 Series radios (other than FR-500-2) feature "Dual Watch" which allows the user to transmit and receive on one channel while monitoring another channel, and "Roger Beep," a signal to alert the person that transmission has stopped so the other person can start to talk.

Ralph Etna, VP Sales of Audiovox Corp's Consumer Goods Group, says that particular interest is being given to the FR-560FM-2. "It could be the new metallic blue finish, or the built-in FM radio that delivers station reception with crystal-clear clarity, or both. It was initially thought that the 560FM would appeal, primarily, to the youth market because of its looks, performance, and the FM feature, but we see sales going to a much broader age group."

Etna also reports a good response to the new GMRS-1525 General Mobile Radio Service heavy duty radio featuring up to five miles range, which he calls "our industrial strength model." In addition to its two-watt power, the GMRS-1525 features contemporary cosmetics and built-in VOX for hands-free operation. With its exceptional transmission range, this radio is perfect for commercial indoor and outdoor use like construction and surveying, as well as for enthusiasts such as hunters, skiers and backpackers.

About Audiovox

Audiovox Corporation is a leading supplier of autosound, auto security, mobile video, FRS radios, consumer electronics such as home and portable stereos and MP3 players, and cellular telephone products. The company is listed on the Nasdaq as VOXX and can be reached on their website at **www.audiovox.com**

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TRAVELPILOT® DX-N CAR NAVIGATION SYSTEM

Blaupunkt has introduced and begun deliveries of its TravelPilot DX-N high-end stand-alone vehicle navigation and voice route guidance system. The Blaupunkt TravelPilot DX-N consists of a five-inch color LCD video map display, that can also be used for in-car video, a trunk-mounted navigation computer, and a handheld remote

Continued on page 82

reader FeedBack

Radio Articles Not Receiving Well

Dear Editor:

Although I've appreciated your recent radio articles, a couple of them have subtle flaws. Although the flaws are not fatal, they have made me think about some difficult design issues. Many of the problems relate to impedance matching, transmission lines, and the failure to specify the design impedance.

Peter Lehmann's "An Easily Built & Practical SWBB Receiver" (February 2000) catches me several ways. The dipole antenna is electrically short and thus mismatched to the 300 ohm transmission line. The input coupling circuit uses loose coupling to the input tank, and that seems to doom good power transfer. The input tank selector has lots of stray capacitance, so the resonant frequencies depend more on construction practices than component values. The bandswitch capacitors should not be connected to the FET all the time, and the main tuning capacitor needs more range. The regeneration control improves the Q, but it may also make a regenerative detector (i.e., the design works, but it may work in unexpected ways).

Joe Carr's Open Channel about VLF radio (August 2000) is more sophisticated, but it omits or misses subtle details. No input connection is shown in Figure 2, and as drawn, C2 and R2 are not needed. Q1 is poorly biased. IDSS for an MPF-102 varies all over the map — from 2mA to 20mA. Consequently, Q1's drain voltage may be anywhere from about a volt to 10 volts, so Q2's bias current can range from 1mA to 30mA. Well-designed circuits have less variation. The FET needs either self bias or feedback biasing. The R4-C4 time constant (1 microsecond) is also too short for an LF receiver.

Figure 3a can be improved and simplified. The antenna coupling capacitor is too large and will load or detune the first resonator. C2 should be eliminated; C3 should have a smaller value (it must only match the antenna coupling capacitance and correct for the mismatch in the ganged capacitor). Alignment (one purpose of C2 and C3) can be achieved by adjusting the variable inductors when C1 is at full mesh, and then C3 is adjusted at minimum mesh. Good designs minimize the number of adjustments. R1 doesn't seem to have a purpose unless it prevents Q1 and Q2 from oscillating (in which case the value seems high, but that might be due to the Darlington's high gain). Also notice that the alignment generator's impedance directly affects the Q of the first resonator (in a well designed filter). Using a generator with a 50-ohm impedance would reduce the Q by a factor of 12 if the filter were designed for 600 ohms. Design impedances should be

Continued on page 82

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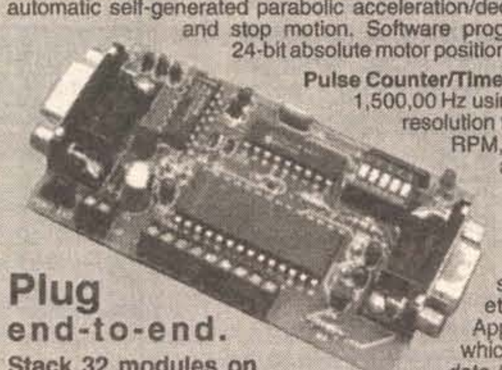

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LED 'GRAPH' CIRCUITS

by Ray Marston

Ray Marston presents a variety of practical LED dot-graph and bar-graph analog-value display circuits.

LED 'GRAPH' DISPLAYS

One of the most popular types of multi-LED indicator circuit is the so called analog-value indicator or 'graph' display, which is designed to drive a chain of linearly-spaced LEDs in such a way that the length of chain that is illuminated is proportional to the analog value of a voltage applied to the input of the LED-driver circuit, e.g., so that the circuit acts like an analog voltmeter.

Practical graph circuits may be designed to generate either a bar-graph or a dot-graph display. *Figure 1* illustrates the bar-graph principle, and shows a line of 10 LEDs used to represent a linear-scale 0-10V meter that is indicating (a) 7V or (b) 4V; the input voltage value is indicated by the total number of LEDs that are illuminated.

Figure 2 shows the same meter operating in the dot-graph mode; the input voltage value is indicated by the relative position of a single illuminated LED. In reality, the '0' position is often indicated on these scales by a separate LED that is permanently active whenever the display is in use.

A number of special ICs are available for operating general-purpose LED analog-value display systems. For many years, the best known ICs of this type were the U237 (etc.) family from AEG, the UAA170 (etc.) family from Siemens, and the LM3914 (etc.) family from National Semiconductors. But the first two of these families have now ceased production, and only the LM3914 family remains. The LM3914 family are popular and versatile ICs that can each directly drive up to 10 LEDs (but can easily be cascaded to drive larger numbers of LEDs) and can drive them in either bar or dot mode.

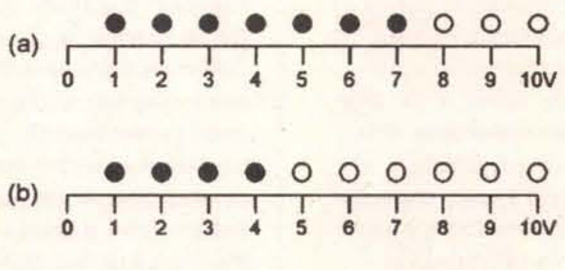

***Figure 1.* Bar-graph indication of (a) 7V and (b) 4V on a 10V 10-LED scale.**

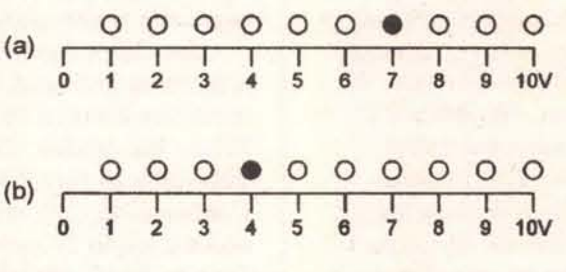

***Figure 2.* Dot-graph indication of (a) 7V and (b) 4V on a 10V 10-LED scale.**

IC-driven bar-graph displays make inexpensive and, in some ways, superior alternatives to analog-indicating moving-coil meters. They are immune to 'sticking' problems, are fast acting, and are unaffected by vibration or by physical attitude.

Their scales can easily be given any desired shape. In a given display, individual LED colors can be mixed to emphasize particular sections of the display, and 'over-range' detectors can easily be activated from the driver ICs and used to sound an alarm and/or flash the entire display under the over-range condition.

LED 'graph' displays have better linearity than conventional moving-coil meters; typical linear accuracy being 0.5%. The scale's resolution depends on the number of LEDs used; a 10-LED display gives adequate resolution for many practical purposes. A wide variety of multi-LED LM3914-based graph display circuits are shown in this article.

LM3914-FAMILY BASICS

The LM3914 family of dot/bar-graph driver ICs are manufactured by National Semiconductors. They are moderately complex but highly versatile devices, housed in 18-pin DIL packages and each capable of directly driving up to 10 LEDs in either the dot or the bar mode.

The family comprises three devices, these being the LM3914, the LM3915, and the LM3916; they all use the same basic internal circuitry (see *Figure 3*), but differ in the style of scaling of the LED-driving output circuitry, as shown in *Figure 4*.

Thus, the LM3914 is a

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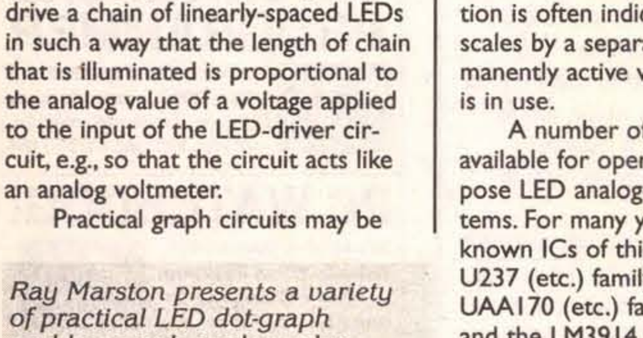

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LED 'GRAPH' CIRCUITS

linearly-scaled unit, specifically intended for use in LED voltmeter applications in which the number of illuminated LEDs gives a direct indication of the value of an input voltage (or of some parameter that is represented by a proportional voltage). The LM3915, on the other hand, has a log-scaled output designed to span -27dB to 0dB in 10 -3dB steps, and is specifically designed for use in power-indicating applications, etc. Finally, the LM3916 has a semi-log scale that spans 23dB, and is specifically designed for use in VU meter applications.

All three devices of the LM3914 family use the same basic internal circuitry, and *Figure 3* shows the specific internal circuit of the linear-scaled LM3914, together with the connections for making it act as a simple 10-LED 0-1.2V meter.

The IC contains 10 voltage comparators, each with its non-inverting terminal taken to a specific tap on a floating precision multi-stage potential divider and with all inverting terminals wired in parallel and accessible via input pin 5 and a built-in unity gain buffer amplifier.

The output of each comparator is externally available, and can sink up to 30mA; the sink currents are internally limited, and can be externally pre-set via a single resistor (R1).

The IC also contains a floating 1.2V reference source between pins 7 and 8. In *Figure 3*, the reference is shown externally connected to the internal potential divider (pins 4 and 6). Note that pins 8 and 4 are shown grounded so, in this case, the bottom of the divider is at zero volts and the top is at 1.2V. The IC also contains a logic network that can be externally set (via pin 9) to give either a dot or a bar display from the outputs of the 10 comparators. The IC operates as follows.

Assume that the IC logic is set for bar-mode operation, and that the 1.2V reference is applied across the internal 10-stage divider as shown. Thus, 0.12V is applied to the inverting or reference input of the lower comparator, 0.24V to the next, 0.36V to the next, and so on. If a slowly rising input voltage is now applied to pin 5 of the IC, the following sequence of actions takes place.

LED number	Typical threshold-point values, for 10V f.s.d.					
	LM3914	LM3915		LM3916		
	V	V	dB	V	dB	VU
1	1.00	0.447	-27	0.708	-23	-20
2	2.00	0.631	-24	2.239	-13	-10
3	3.00	0.891	-21	3.162	-10	-7
4	4.00	1.259	-18	3.981	-8	-5
5	5.00	1.778	-15	5.012	-6	-3
6	6.00	2.512	-12	6.310	-4	-1
7	7.00	3.548	-9	7.079	-3	0
8	8.00	5.012	-6	7.943	-2	+1
9	9.00	7.079	-3	8.913	-1	+2
10	10.00	10.000	0	10.000	0	+3

***Figure 4.* Threshold-point values of the LM3914/15/16 range of ICs when designed to drive 10 LEDs at a full-scale sensitivity of 10V.**

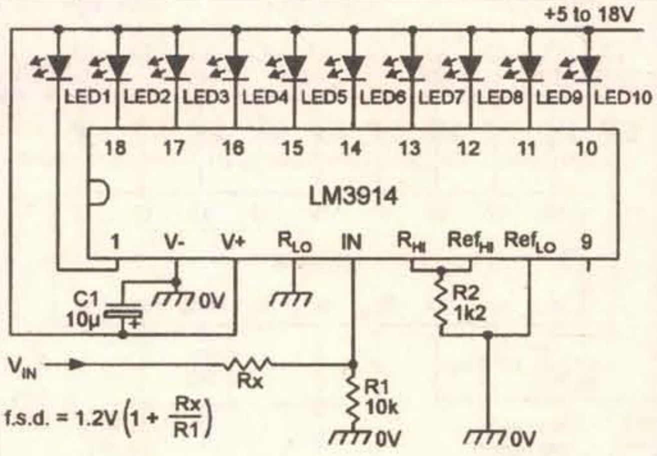

***Figure 5.* 1.2V to 1000V FSD dot-mode voltmeter.**

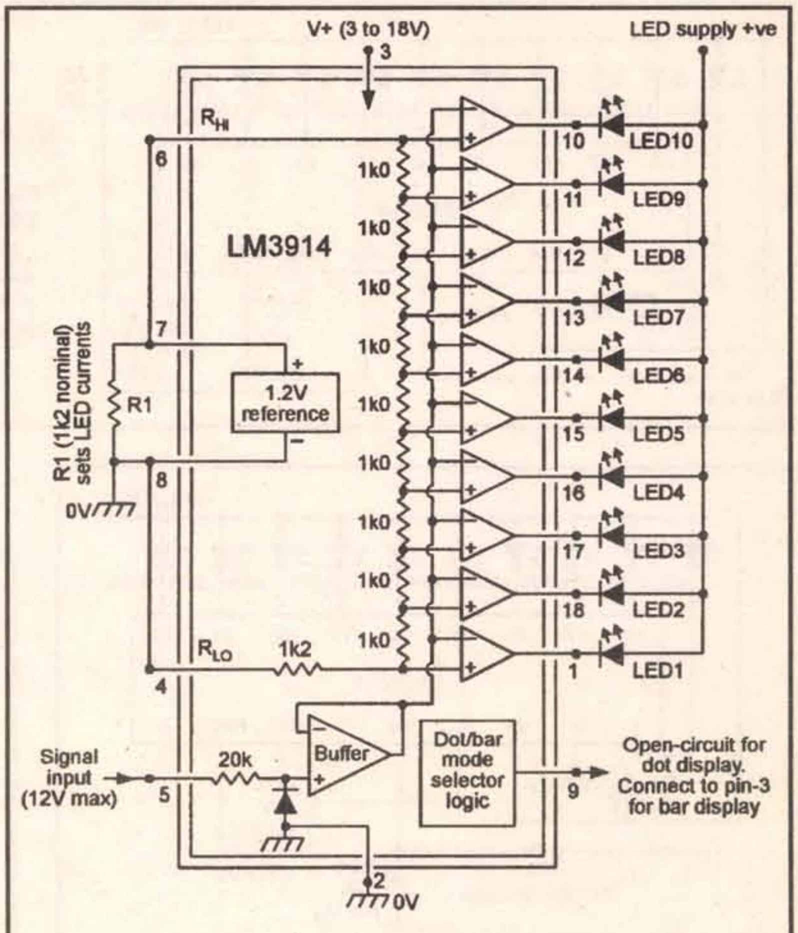

***Figure 3.* Internal circuit of the LM3914, with connections for making a 10-LED 0-1.2V linear meter with dot- or bar-graph display.**

When the input voltage is zero, the outputs of all 10 comparators are disabled and all LEDs are off. When the input voltage reaches the 0.12V reference value of the first comparator, its output conducts and turns LED1 on. When the input reaches the 0.24V reference value of the second comparator, its output also conducts and turns on LED2 so, at this stage, LEDs 1 and 2 are both on.

As the input voltage is further increased, progressively more and more comparators and LEDs are turned on until eventually, when the input rises to 1.2V, the last comparator and LED10 turn on, at which

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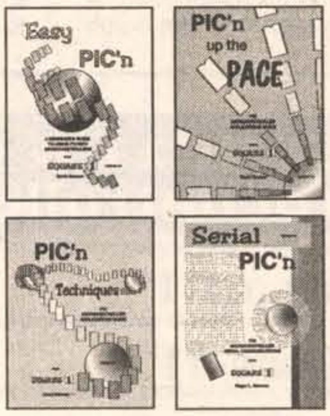

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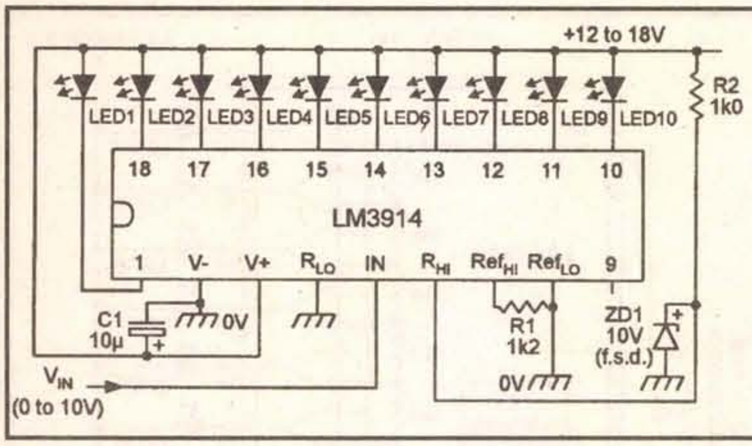

Figure 6. **10V FSD meter using an external reference.**

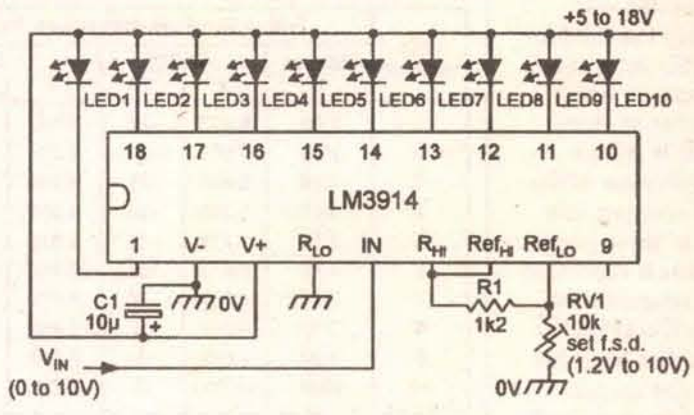

Figure 7. **An alternative variable-range (1.2V to 10V) dot-mode voltmeter.**

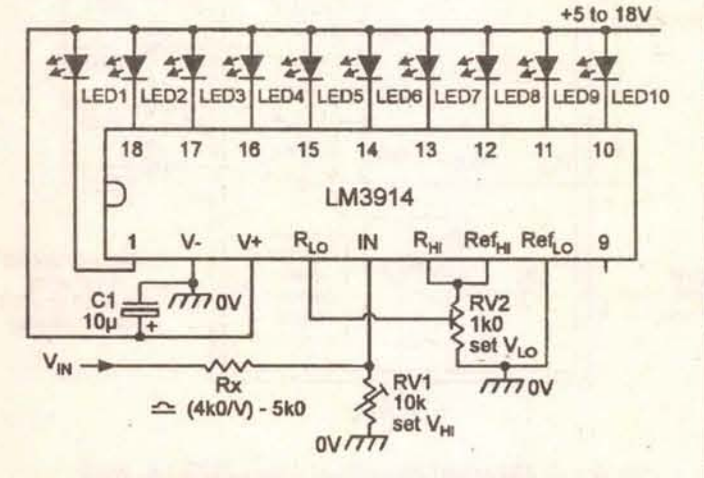

Figure 8. **Expanded-scale (10V-15V, etc.) dot-mode voltmeter.**

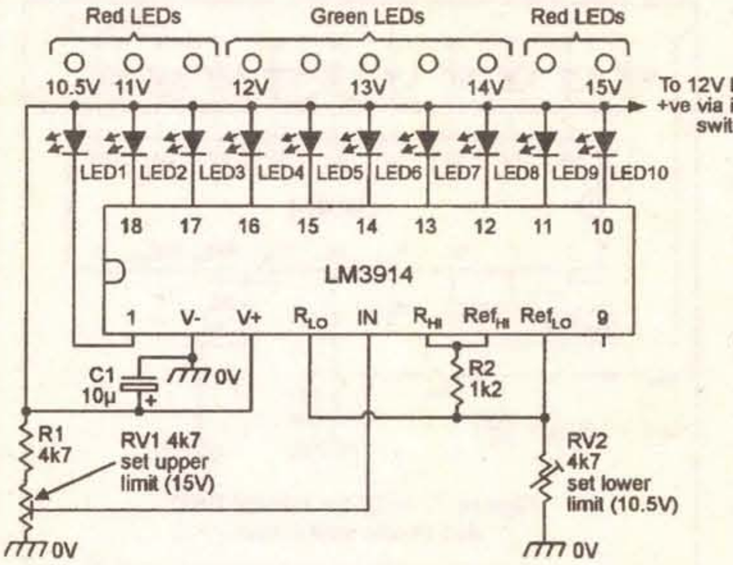

Figure 9. **Expanded-scale dot-mode vehicle voltmeter.**

point all LEDs are on.

A similar kind of action is obtained when the LM3914 logic is set for dot mode operation, except that only one LED is on at any given time; at zero volts no LEDs are on, and at 1.2V and greater only LED10 is on.

SOME FINER DETAILS

In *Figure 3*, R1 is shown connected between pins 7 and 8 (the output of the 1.2V reference) and determines the ON currents of the LEDs. The ON current of each LED is roughly 10 times the output current of the 1.2V source, which can supply up to 3mA, and thus enables LED currents of up to 30mA to be set via R1. If, for example, a total resistance of 1k2 (equal to the paralleled values of R1 and the 10k of the ICs internal potential divider) is placed across pins 7 and 8, the 1.2V source will pass 1mA and each LED will pass 10mA in the ON mode.

Note from the above that the IC can pass total currents up to 300mA when used in the bar mode with all 10 LEDs on. The IC has a maximum power rating of only 660mW, however, so there is a danger of exceeding this rating when the IC is used in the bar mode. In practice, the IC can be powered from DC supplies in the range of three to 25 volts, and the LEDs can use the same supply as the IC or can be independently powered; this latter option can be used to keep the IC power dissipation at a minimal level.

The internal 10-stage potential divider of the IC is floating, with both ends externally available for maximum versatility, and can be powered from either the internal reference or from an external source or sources. If, for example, the top of the chain is connected to a 10V source, the IC will function as a 0-10V meter if the low end of the chain is grounded, or as a restricted-range 5-10V meter if the low end of the chain is tied to a 5V source.

The only constraint on using the divider is that its voltage must not be greater than 2V less than the ICs supply voltage (which is limited to 25V maximum). The input (pin 5) to the IC is fully protected against overload voltages up to plus or minus 35V.

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LED 'GRAPH' CIRCUITS

The internal voltage reference of the IC produces a nominal output of 1.28V (limits are 1.2V to 1.34V), but can be externally programmed to produce effective reference values up to 12V (as shown later).

The IC can be made to give a bar display by wiring pin 9 directly to pin 3 (positive-supply), or — if only one IC is used — can be made to give a dot display by leaving pin 9 open circuit or by pulling it at least 200mV below the pin 3 voltage value.

If two or more ICs are cascaded to drive 20 or more LEDs in the dot mode, pin 9 must (except in the case of the final IC in the chain) be wired to pin 1 of the following IC, and a 20k resistor must be wired between pin 11 and the LED-powering positive supply rail.

Finally, note that the major difference between the three members of the LM3914 family of ICs lies in the values of resistance used in the internal 10-stage potential divider. In the LM3914, all resistors in the chain have equal values, and thus produce a linear display of 10 equal steps. In the LM3915, the resistors are logarithmically weighted, and thus produce a log display that spans -27dB to 0dB in 10 -3dB steps. In the LM3916, the resistors are weighted in semi-log fashion and produce a display that is specifically suited to VU-meter applications.

Let's now move on and look at some practical applications of this series of devices, paying particular attention to the linear LM3914 IC.

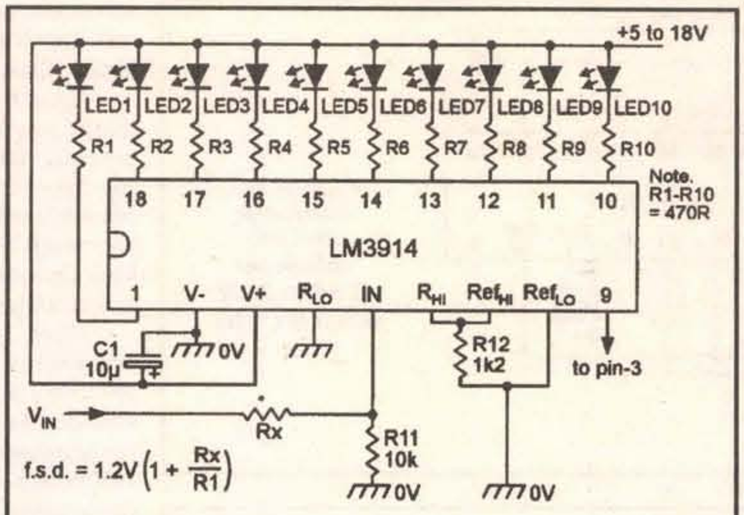


Figure 11. **Bar-display voltmeter with common LED/IC supply.**

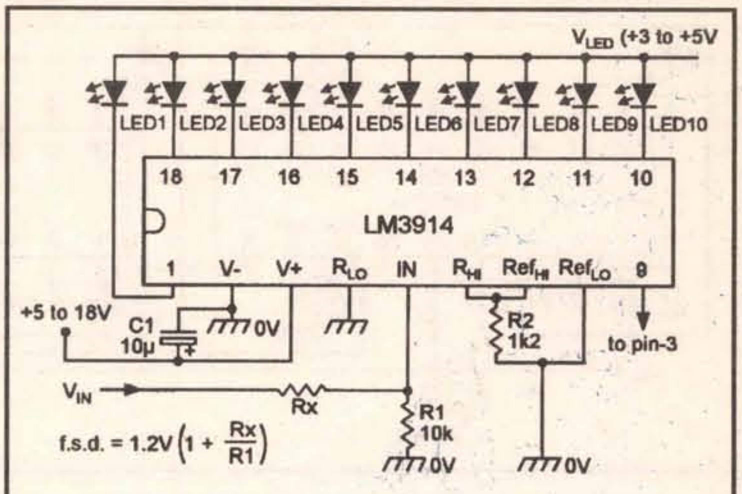


Figure 10. **Bar-display voltmeter with separate LED supply.**

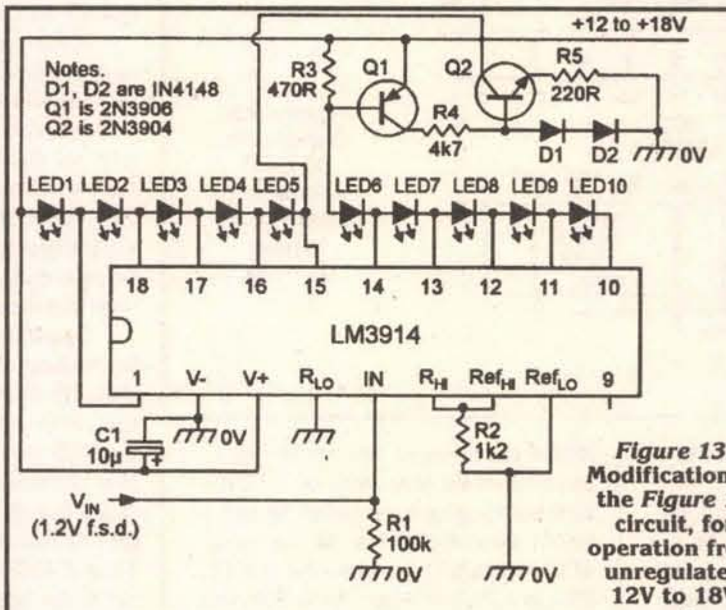


Figure 13. **Modification of the *Figure 12* circuit, for operation from unregulated 12V to 18V supplies.**

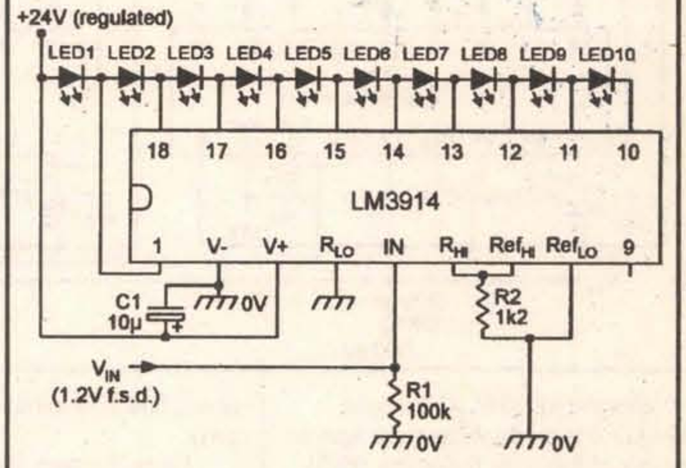
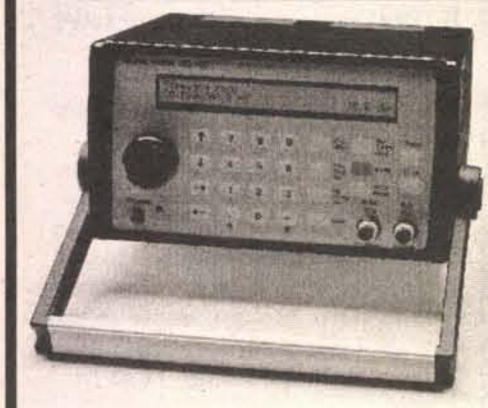


Figure 12. **Method of obtaining a bar display with dot-mode operation and minimal current consumption.**

DOT-MODE VOLTMETERS

Figures 5 to *9* show various ways



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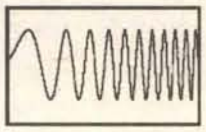

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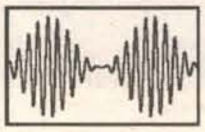

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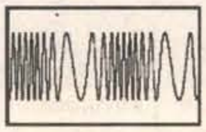

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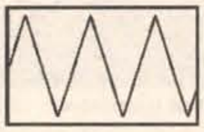
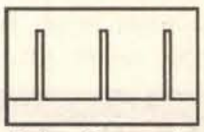
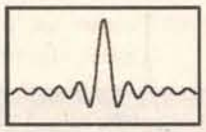


Ramps, Triangles, Exponentials



Pulse Generator

Noise



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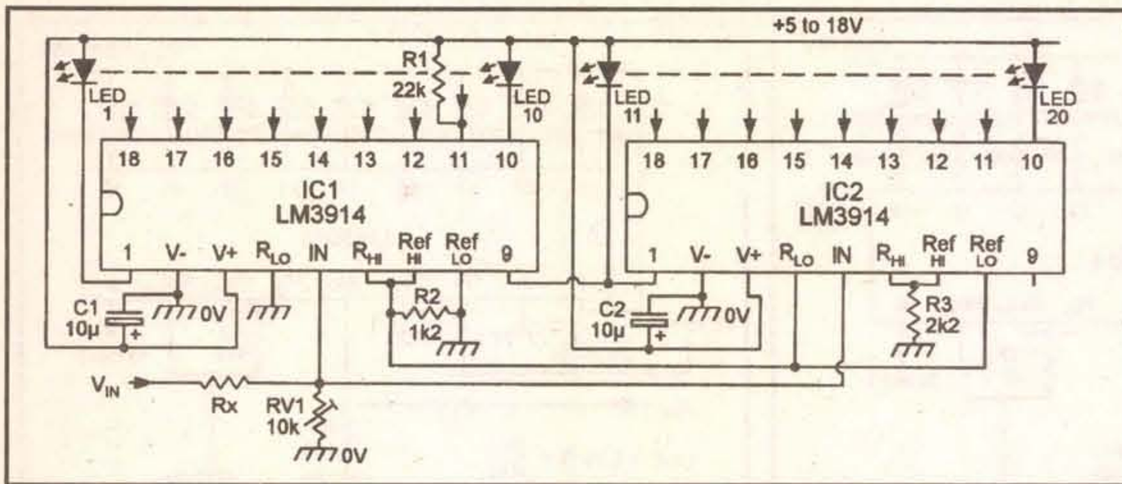

Figure 14. **Dot-mode 20-LED voltmeter (FSD = 2.4V when Rx = 0).**

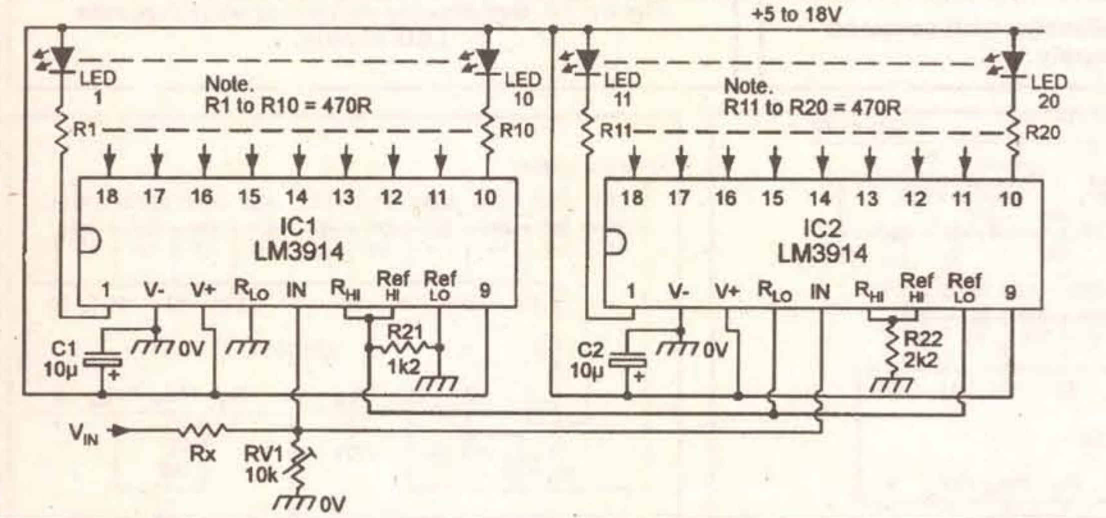

Figure 15. **Bar-mode 20-LED voltmeter (FSD = 2.4V when Rx = 0).**

of using the LM3914 IC to make 10-LED dot-mode voltmeters with a variety of full-scale deflection (FSD) sensitivities. Note in all these circuits that pin 9 is left open-circuit to give dot-mode operation, and that a 10µF capacitor is wired directly between pins 2 and 3 to enhance circuit stability.

Figure 5 shows the connections for making a variable-range (1.2V to 1000V FSD) voltmeter. The low ends of the internal reference and divider are grounded and their top ends are joined together, so the meter has a basic full-scale sensitivity of 1.2V, but variable ranging is provided by the Rx-R1 potential divider at the input of the circuit. Thus, when Rx is zero, FSD is 1.2V, but when Rx is 90k, the FSD is 12V. Resistor R2 is wired across the internal reference and sets the ON currents of the LEDs at about 10mA.

Figure 6 shows how to make a fixed-range 0-10V meter, using an external 10V zener (connected to the top of the internal divider) to provide a reference voltage. The supply voltage to this circuit must be at least two volts greater than the zener reference voltage.

Figure 7 shows how the internal reference of the IC can be made to effectively provide a variable voltage, enabling the meter FSD value to be set anywhere in the range 1.2V to 10V. In this case, the 1mA current (determined by R1) of the floating 1.2V internal reference flows to ground via RV1, and the resulting RV1-voltage raises the reference pins (pins 7 and 8) above zero.

If, for example, RV1 is set to 2k4, pin 8 will be at 2.4V and pin 7 at 3.6V. RV1 thus enables the pin 7 voltage (connected to the top of the internal divider) to be varied from 1.2V to about 10V, and thus sets the FSD value of the meter within these values. Note that the circuit's supply voltage must be at least 2V greater than the desired FSD voltage value.

Figure 8 shows the connections for making an expanded- scale meter that, for example, reads voltages in the range 10 to 15 volts. RV2 sets the LED current at about 12mA, but also enables a reference value in the range 0-1.2V to be set on the low (pin 4) end of the internal divider. Thus, if RV2 is set to apply 0.8V to pin 4, the basic meter will read voltages in the range 0.8 to 1.2 volts only. By fitting potential divider Rx-RV1 to the input of the circuit, this range can be amplified to (say) 10-15V, or whatever range is desired.

Finally, *Figure 9* shows an expanded scale dot-mode voltmeter that is specifically designed to indicate the value of a vehicle's battery (12V nominal). In this case, R2-RV2 are effectively set to give a basic range of 2.4 to 3.6 volts, but the input to the circuit is derived from the positive supply rail via the R1-RV1 potential divider, and the indicated volts reading thus corresponds to a pre-set multiple of the basic range value. As shown in the diagram, red and green LEDs can be used in the display, arranged so that green LEDs illuminate when the voltage is in the 'safe' range 12 to 14 volts.

To calibrate the above circuit, first set the supply to 15 volts and adjust RV1 so that LED 10 just turns on. Reduce the supply to 10V and adjust RV2 so that LED 1 just turns on. Recheck the settings of RV1 and RV2. The calibration is then complete and the unit can be installed in the vehicle by taking the '0' volt lead to chassis and the '+12V' lead to the vehicle's battery via the

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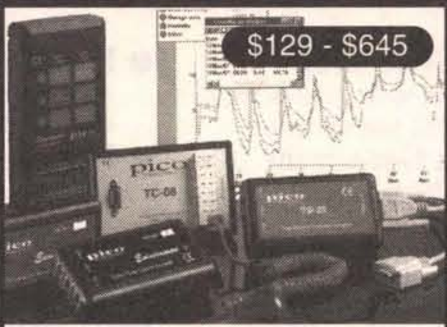

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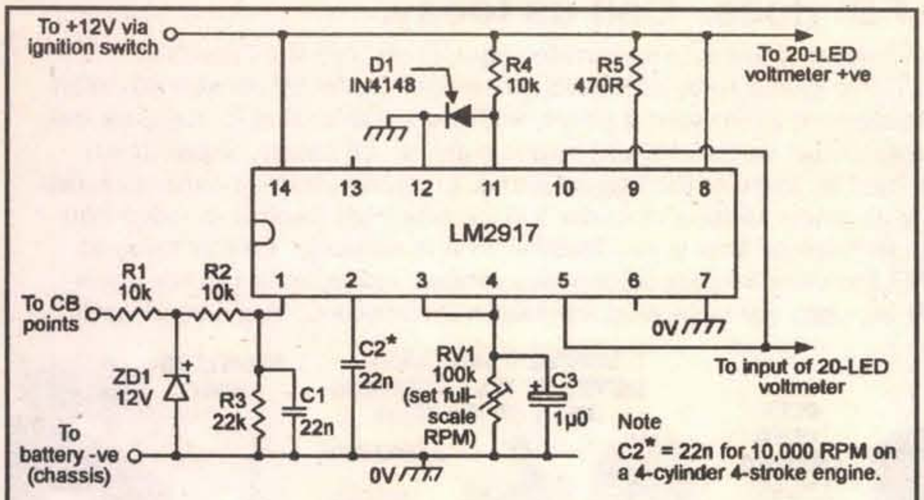

Figure 16. **Vehicle tacho conversion circuit for use with a 20-LED voltmeter.**

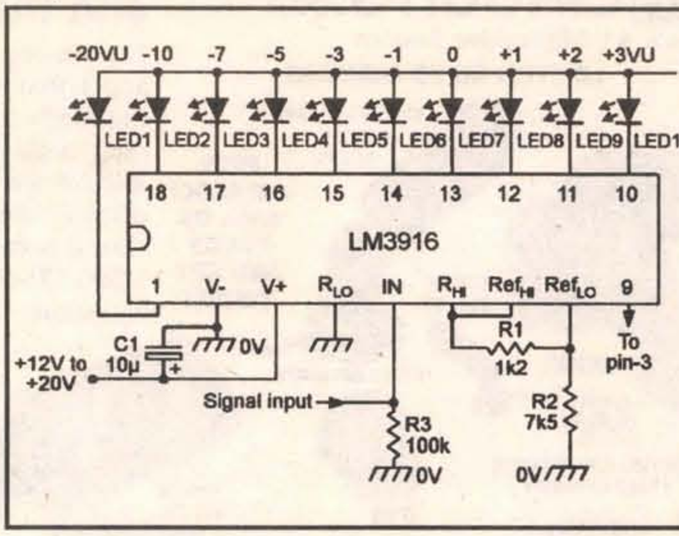

Figure 18. **Basic bar-mode VU-meter circuit.**

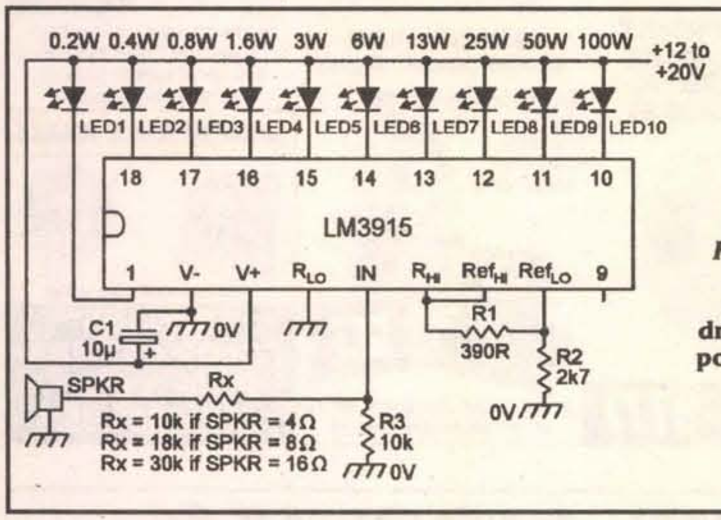

Figure 17. **Simple speaker-driven audio power meter.**

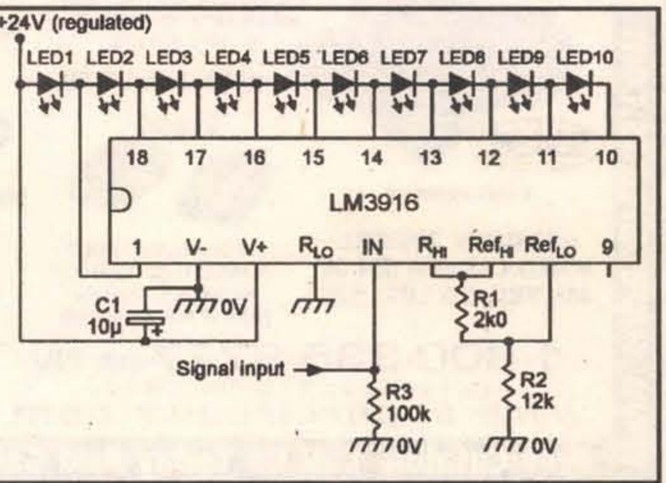

Figure 19. **This basic VU-meter circuit gives a bar-type display, with a dot-type current drain.**

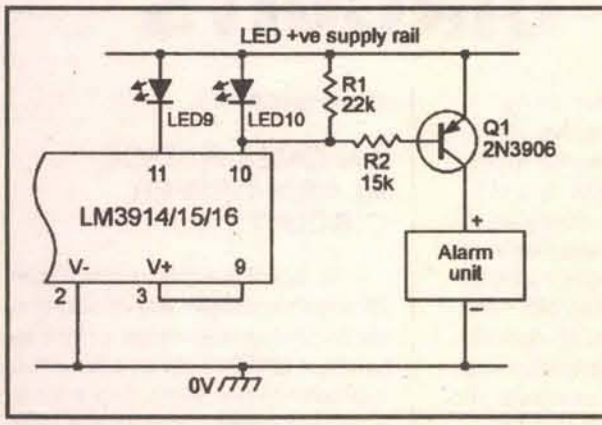

Figure 20. **An over-range alarm-driver circuit, for use with bar-type displays.**

ignition switch.

BAR-MODE VOLTMETERS

The dot-mode circuits of *Figures 5* to *9* can be made to give bar-mode operation by simply connecting pin 9 to pin 3, rather than to pin 11. When using the bar mode, however, it must be remembered that the IC's power rating must not be exceeded by allowing excessive output-terminal voltages to be developed when all 10 LEDs are on. LEDs drop roughly 2V when they are conducting, so one way around this problem is to power the LEDs from their own low-voltage (3 to 5V) supply, as shown in *Figure 10*.

An alternative solution is to power the IC and the LEDs from the same supply, but to wire a current-limiting resistor in series with each LED, as shown in *Figure 11*, so that the IC's output terminal saturates when the LEDs are on.

Figure 12 shows another way of obtaining a bar display without excessive power dissipation. Here, the LEDs are all wired in series, but with each one connected to an individual output of the IC, and the IC is wired for dot-mode operation.

Thus, when (for example) LED 5 is on, it draws its current via LEDs 1 to 4, so all five LEDs are on and the total LED current equals that of a single LED, and total power dissipation is quite low. The LED supply to this circuit must be greater than the sum of all LED volt-drops when all LEDs are on, but must be within the voltage limits of the IC; a regulated 24V supply is thus needed.

Figure 13 shows a very useful modification which enables the above circuit to be powered from unregulated supplies within the 12 to 18 volt range. In this case, the LEDs are split into two chains, and the transistors are used to switch on the lower (LEDs 1 to 5) chain when the upper chain is active; the maximum total LED current equals twice the current of a single LED.

20-LED VOLTMETERS

Figure 14 shows how two LM3914 ICs can be inter-connected to make a 20-LED dot-mode voltmeter. Here, the input terminals of the two ICs are wired in parallel, but IC1 is configured so that it reads 0 to 1.2 volts, and IC2 is configured so that it reads 1.2 to 2.4 volts. In the latter case, the low end of the IC2 potential divider is coupled to the 1.2V reference of IC1, and the top end of the divider is taken to the top of the 1.2V reference of IC2, which is raised 1.2V above that of IC1.

The 20-LED *Figure 14* circuit is wired for dot-mode operation and, in this case, pin 9 of IC1 is wired to pin 1 of IC2, pin 9 of IC2 is open circuit, and a 22k resistor is wired in parallel with LED 9 of IC1.

Figure 15 shows the connections for making a 20-LED bar-mode voltmeter. The connections are similar to those of *Figure 14*, except that pin 9 is taken to pin 3 on each IC, and a 470R current-limiting resistor is wired in series with each LED to reduce the power dissipation of the ICs.

To conclude this look at LM3914 circuits, *Figure 16* shows a simple frequency-to-voltage converter that can be used to convert either of the *Figure 14* or *15* circuits into 20-LED tachometers (RPM-meters).

This converter should be interposed between the vehicle's contact-breaker points and the input of the voltmeter circuit. *In Figure 16*, the C2 value of 22n is the optimum value for a full-scale range of 10,000 RPM on a four-cylinder four-stroke engine. For substantially lower full-scale RPM values, the C2 value may have to be increased — the value may have to be reduced on vehicles with six or more cylinders.

LM3915/LM3916 CIRCUITS

The LM3915 'log' and LM3916 'semi-log' ICs operate in the same basic way as the LM3914, and can in fact be directly used in most of the circuits shown in *Figures 5* to *15*. In most practical applications, however, these particular ICs are used to indicate the value of an AC input signal, and the simplest way of achieving such a display is to connect the AC signal directly or via an

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attenuator to the pin 5 input terminal of the IC, as shown in *Figure 17*. The IC responds only to the positive halves of such input signals, and the number of illuminated LEDs is thus proportional to the instantaneous peak value of the input signal.

The *Figure 17* circuit is that of a simple LM3915-based audio power meter that is used to indicate instantaneous output voltage values from an external loudspeaker. Pin 9 is left open-circuit to give dot-mode operation, and R1 has a value of 390R to give an LED current of about 30mA, thus giving a clear indication of brief instantaneous voltage levels. The meter gives audio power indication over the range 200mW to 100W.

Figure 18 shows the basic way of using the LM3916 IC as a VU-meter with a full-scale sensitivity of 10V DC. The circuit is shown connected for bar-mode operation, using separate supply voltages for the LED display and for the actual IC, and with the component values shown, gives a current drive of 10mA to each active LED.

If preferred, the IC can be used to give dot-mode operation, using a common 12V to 20V supply for the LEDs and the IC, by leaving pin 3 open circuit and changing the R1-R2 values to 390R-2k4, thus giving 30mA of drive to the active LEDs.

Figure 19 shows an alternative way of using the LM3916 as a VU-meter with a bar-type display. In this case, the IC is used in the same way as the basic *Figure 12* low-current-consumption circuit, with pin 9 left open circuit so that the IC actually operates in the dot mode, but with the LEDs wired in series across the display-driving pins so that a bar-type display is obtained, with all active LED currents flowing through the currently-active driving pin. With the component values shown, this circuit has a full-scale sensitivity of 10V and provides a LED-drive current of 16mA.

The basic *Figures 17* to *19* LM3915 and LM3916 circuits are shown being driven directly from AC signal inputs, and this technique is adequate in many applications.

In cases where the display is required to relate specifically to peak — RMS — or average values of AC input voltage, this can be achieved by interposing a suitable AC-DC converter circuit between the AC signal and the pin 5 input terminal of the LM3915 or LM3916 IC. Many suitable circuits are published in op-amp application manuals and circuit reference books and encyclopedias, etc.

AN OVER-RANGE ALARM-DRIVER CIRCUIT

To conclude this article, *Figure 20* shows a simple way of fitting an alarm-driving over-range switch to a bar-type LM3914-series LED-driving indicator circuit. Here, pnp transistor Q1 is wired between the LED positive supply rail and the 0V rail, with its base connected to the IC's pin 10 (which drives LED10) and with a self-contained alarm unit wired in series with its collector. Normally, LED10, Q1, and the alarm are all off, but if LED10 turns on, it pulls Q1, on via R2 and thus activates the alarm unit, which indicates the 'over-range' condition.

In this circuit, the alarm unit may take the form of a piezo siren unit that generates an acoustic alarm sound, or a gated astable switch unit that repeatedly switches the LED brightness between high and low levels under the over-range condition, or may be a combination of both of these units. If desired, the unit can be activated by any one of the display LEDs, in which case, the alarm will activate whenever that or any higher LED is energized. **NV**

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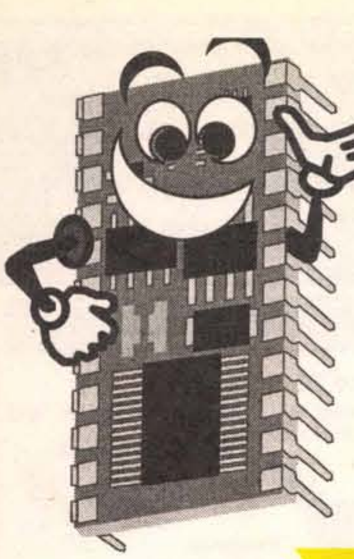


by Jon Williams

Stamp Applications

A TALKING PET TRAINER

Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips

Aside from being hard to find, the SPO256-AL2 has a very tinny, robotic quality to the speech. This is actually kind of cool for robotics, but some applications require higher quality speech and may even need non-speech sounds.

During my first run with this column, I wrote an article on using the long-obsolete — but still available — SPO256-AL2 allophone speech synthesizer. That one article has generated more email than all the rest of my articles combined. Clearly, Stamp enthusiasts are interested in speech.

Enter the ISD25xxx series of chips. These digital recorders are easy to find and equally easy to use. They differ from the SPO256-AL2 in that they do not come with stored sounds or speech; it is up to you to put those in. Once a message has been recorded, it is stored in non-volatile memory. This means you won't lose your recording when power is removed from the circuit. This is particularly useful in battery-powered applications.

Polly Want A Stamp?

I got started with the ISD at the request of my friend, Mike. At the time, Mike was a fledgling Stamper that went out and bought a parrot — a big, beautiful, very expensive parrot. With the investment, Mike figured the bird should learn to talk. Using a BS2 and an ISD2560, he built the first version of his parrot trainer. While workable, he felt like the circuit and software could use some refinement so he sent it to me.

This ISD25xxx is a moderately sophisticated component and has several modes of operation. Our application will use the simplest operational mode: M6 (also referred to as Push-Button mode). In this mode, the device has the ability to record and playback a single message.

Figure 1 is the schematic for the IS25xxx circuit in Push-Button mode. This circuit was lifted right out of the ISD documentation. The only modification I made was to remove the switches and to add 10K pull-ups to the control inputs (CE\, PD, and P-R\). This portion of the project is, in fact, a stand-alone module and you could experiment with the ISD by adding a normally-open push button to CE\ and SPST switches to the PD and P-R\ inputs.

Note that this circuit is compatible with the ISD2560, ISD2575, ISD2590, and ISD25120. These parts differ in the length of the recorded message space (60, 75, 90, and 120 seconds). The increase in storage space is accomplished by lowering the audio sampling rate. This does give you more storage, but the price you pay is in sound quality. I stuck with the ISD2560 because 60 seconds is quite long and the quality is very good. I personally found the sound quality of the ISD25120 unacceptable for this project.

Using the ISD25xxx in Push-Button mode is very easy. Here are the steps:

1. Bring PD high, then low to stop the current cycle and reset the device.
2. Set PR high to play, low to record.
3. "Blip" the CE\ line (high-low-high) to start the cycle.
4. Bring PD high to stop record cycle and reset the device.

Let's get back to the parrot trainer application. What Mike wanted to do is record a message, press a button to test it, and press another button to play the message back several times after a short delay. The idea behind the delay is to allow him to leave the room and let the bird get settled before the training begins. His original circuit connected the push buttons directly to the ISD and monitored them with the Stamp. I changed this to allow total software control of the ISD. This way, the buttons can be software-debounced and we have more flexibility with the ISD module for future applications.

Figure 2 is the control interface for the Stamp 2. On pins 12, 13, and 14 is standard push-button input that I've used in several other projects. For review, the 220-ohm resistors on these pins protect the Stamp in the event that one of those pins is accidentally configured as an output and set high (five volts) while the button on that line is pressed. If we had this condition without the resistors, we'd have a direct short to ground and would damage the Stamp.

Pin 15 (RecRun) monitors the EOM\ line from the ISD25xxx. In Push-Button mode, this line goes high while a message is playing or being recorded. Notice that I've also tied this line to the anode side of the Record (red) and Play (green) LEDs. By doing this, I know that the ISD is working. The appropriate LED is selected by making its output line (6 for record, 7 for play) low.

Pin 8 controls the Train (yellow) LED. In our application, this LED will blink while in the delay period and be on solid while the training period (the time when the recorded message is being repeated) is in progress. Pins 9, 10, and 11 are the control outputs to the ISD. Okay, let's jump into the code.

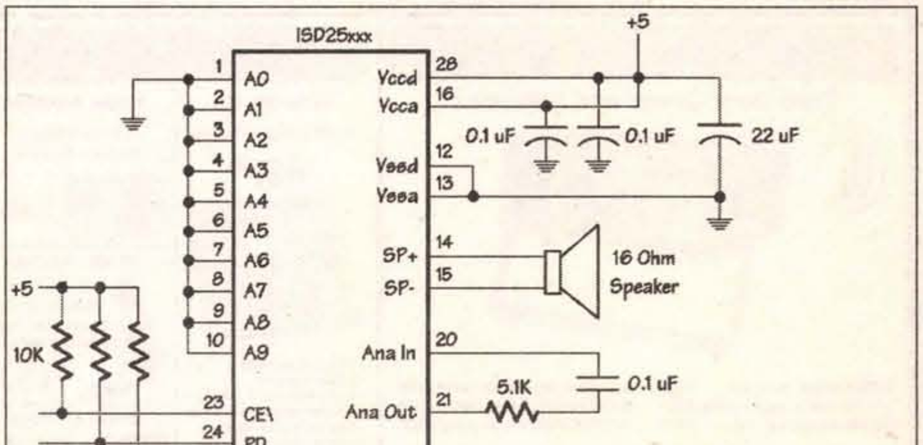
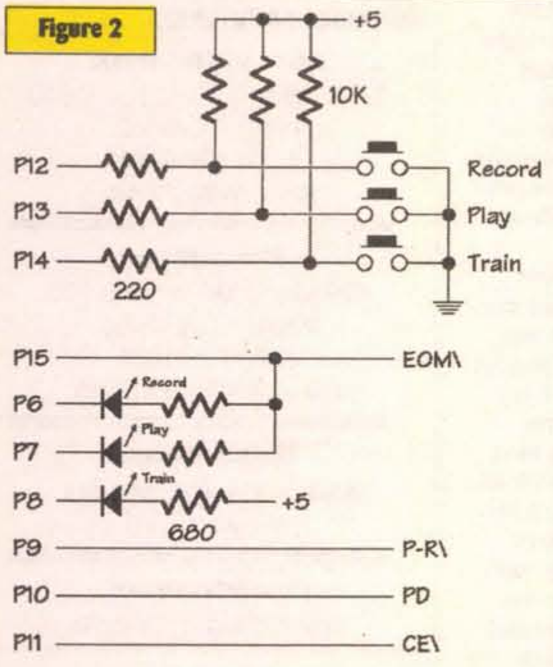


Figure 1

A TALKING PET TRAINER

Figure 2



Setting PD, CE\, and PR high initializes the ISD25xxx. This causes the device to reset and defaults to play mode. All of the LEDs are extinguished by setting their control outputs high. Finally, PD is brought back low, bringing the ISD out of reset and allowing a new cycle to be initiated.

After initializing the program, make sure that there are no stuck buttons by scanning the button inputs until none are pressed. This section of code calls a subroutine **GetBtn** to scan and debounce the button inputs. I've used this code before, but I think its operation is worth repeating since button debouncing is important and this subroutine handles multiple inputs.

Let's start at the end. When we return from **GetBtn**, the variable called ***btns*** will hold the debounced inputs. We start, then, by enabling specific inputs by setting those bits in ***btns***. Then we scan the inputs and logically AND the new inputs with the current value. Since our inputs are active-low, we use the inversion operator (~) to correct them. Any input that is not active will then have a value of zero. As you know, zero ANDed to any value is zero. This eliminates that particular input for this iteration of **GetBtn**. The inputs are scanned five times using a **FOR-NEXT** loop. With a 10-millisecond **PAUSE** in the loop, the subroutine takes just over 50 milliseconds to run. If an input is active through all five loops of the routine, its bit in ***btns*** will remain set (1) and be returned to the program as a valid input.

Back in the main program, we'll actually spend most of our time at the label called Scan. At this point, we get the inputs, use **LOOKDOWN** to convert the buttons to a value from 0 to 3, then use **BRANCH** with this value to jump to the code that corresponds to our button input.

Let's start by recording a message. To do this, we press and hold the Record button. This causes the program to **BRANCH** to _Rec. There's a 250-millisecond delay here to allow us to be ready to record. PR is taken low to put the ISD25xxx into record mode, then the record cycle is started by "blipping" the CE line. Advanced Stamp programmers will probably wonder why I didn't use **PULSOUT** to take care of the blip. I tried this method and got inconsistent results (maybe I have a marginal part). Anyway, I ended up just brute-forcing it with the **Blip** subroutine.

Once the ISD25xxx is activated, making Pin 6 low enables the Record LED. Remember that the EOM\ line on the ISD25xxx goes high during playback and recording. With Pin 6 low and the EOM\ high, the Record LED will light.

The program then monitors the Record input and stays in a tight loop (at the label RLoop) until the button is released. When this happens, the record cycle is halted and making PD high resets the ISD25xxx. The program then jumps back to the initialization section to clean up everything before waiting for the next input.

Now that we've got a message recorded, we can test it by pressing the Play button. This causes the program to **BRANCH** to Play. This code starts

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```
' -----[ Title ]-----------------------------------------------------------
-
'
' File...... PARROT.BS2
' Purpose... ISD25xxx Controller
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' Started... 03 APR 1999
' Updated... 29 JUL 2000


' -----[ Program Description ]---------------------------------------------
-
'
' This program, based on an original by Mike Politoski, controls
anISD25xxx
' series ChipCorder(r) IC.  This program allows the user to record a
' message (length determined by the chip) and play it back several times
' to train a parrot or other talking bird.
'
' Note: The ISD25xxx is configured for Mode 6, push-button mode.
'
' Modes:
'
' - Record:   Press and hold record button
' - Play:     Press play button
' - Training: Press start button


' -----[ I/O Definitions ]-------------------------------------------------
-
'
LEDr_    CON     6                    ' recording LED
LEDp_    CON     7                    ' playback LED
LEDt_    CON     8                    ' training LED

PR       CON     9                    ' ISD Play/Record_
PD       CON     10                   ' ISD Power Down
CE_      CON     11                   ' ISD Chip Enable

BtnRec   VAR     In12                 ' Record control button
BtnPlay  VAR     In13                 ' Play control button
BtnGo    VAR     In14                 ' Start control button
RecRun   VAR     In15                 ' recording/running out from ISD
bPort    VAR     InD                  ' buttons port


' -----[ Constants ]-------------------------------------------------------
-
'
On       CON     0                    ' active low
Off      CON     1

Yes      CON     1                    ' active high
No       CON     0


' -----[ Variables ]-------------------------------------------------------
-
'
btns     VAR     Nib                  ' debounced inputs
state    VAR     Byte                 ' button input state
delay    VAR     Word                 ' delay before training
x        VAR     Byte                 ' loop counter
y        VAR     Word                 ' loop counter
plays    VAR     Word                 ' plays counter


' -----[ Initialization ]--------------------------------------------------
-
'
Init:
  HIGH PD                             ' reset ISD address
  HIGH CE_
  HIGH PR                             ' default to Play mode
  HIGH LEDr_                          ' record LED off
  HIGH LEDp_                          ' play LED off
  HIGH LEDt_                          ' train LED off
  PAUSE 30                            ' allow device to reset
  LOW PD                              ' bring out of reset


' -----[ Main Code ]-------------------------------------------------------
-
'
Main:
  GOSUB GetBtn
  IF btns > %000 THEN Main                      ' wait for release

Scan:
  GOSUB GetBtn
  LOOKDOWN btns,[%000, %001, %010, %100],state
```

A TALKING PET TRAINER

with a half-second **PAUSE** to allow us to release the Play button. The PR line is set high for playback mode. As with recording, blipping the CE\ line starts the cycle and making Pin 7 low enables the Play LED. The play LED will remain lit for the duration of the recorded message.

The buttons are monitored during playback to allow us to stop before the end of the message. We can do this by pressing any button. If we press a button during playback, the program jumps back to the initialization section where the cycle is halted and the ISD25xxx is reset.

If no button is pressed, we need to wait until the message is finished before resetting the device and waiting for our next input. We do this by monitoring Pin 15 (RecRun). As we stated before, this line is connected to the EOM\ line of the ISD25xxx and will stay high while the message is playing. While this is the case, the program continues to loop back to the label called PLoop. As soon as this input goes low (playback is finished), the test falls through and the device is reset.

Finally we get to the real purpose behind this project: bird training. The training cycle is initiated by pressing the Train button. This causes the program to **BRANCH** to _Train. Again, we use a short delay to give time for the Train button to be released. Then we light the Train LED by making Pin 8 low.

What we want to do here is flash the Train LED; one half-second on, one half-second off. This would be pretty easy to do with **PAUSE** statements, but it wouldn't allow us to stop the cycle without "pulling the plug" on our project. Instead, we create a half-second (approximate) delay by calling **GetBtn** nine times with a loop. The process gives us the time delay we need and allows us to abort the training cycle if any button is pressed. If no button is pressed, we turn the Train LED off and wait again using the same technique. This on-wait-off-wait cycle is repeated 280 times using a **FOR-NEXT** loop. This results in a delay of about five minutes.

Once we're past the delay, we turn the Train LED on solid and go into the actual training cycle. This is where we will repeat our recorded message 100 times. There is a 30-second delay between the plays unless a button is pressed which would abort the cycle. The code in this section of the program is identical to the code we've just covered so we don't have to go into details.

Wa-la, a bird trainer. Mike reported that it worked exceptionally well and yet, there is plenty of room for upgrades. I found that the ISD25xxx will drive a speaker pretty loudly. If you want volume control (more or less), you can run the output into an LM386 audio amplifier circuit. You might also make the delay time and number of plays variable by adding a couple of switches or pots. For those of you interested in Mike's other bird training projects, check out his web site at www.birdwords.com.

Now some of you know that I have a goldfish and no matter how many times I play messages for him, he's not talking. So, what am I going to do with my trainer? Well, Halloween (my favorite day of the year) is next month and I've got plans to load this dude into a plastic skull. My intention is to use an infrared beam to start the playback, with a randomized delay before the message starts. The randomized delay will help prevent smart-alecs from figuring out how the talking skull works. I'm also going to experiment with using the audio output to modulate glowing LEDs in the eye-sockets of the skull. It should be a fun Halloween ...

If you're not inclined to build your own circuit, Parallax has a new ISD AppMod that gives you serial control over the ISD2560 and up to eight messages. The part number is #29111 and the price is only $89.00.

And for those of you that are inclined to do your own thing and want to pursue more advanced options of the ISD chips, you might want to take a look at products offered by Quadravox. They have parts and modules that give you serial control over the ISD and support multiple messages. I don't have any personal experience with their products, but I've seen some very favorable messages posted to the Stamp mail list about them.

Until next time, Happy Stamping. **NV**

Resources:

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Irving, TX 75062
(972) 659-9090
jonwms@aol.com

Parallax
599 Menlo Drive, Suite 100
Rocklin, CA 95756
(888) 512-1024
www.parallaxinc.com

ISD25xxx Documentation
www.isd.com

Quadravox
www.quadravox.com

```
  BRANCH state,[Scan, _Rec, _Play, _Train]
  GOTO Scan

_Rec:
  PAUSE 250                          ' time to get ready
  LOW PR                             ' record mode
  GOSUB Blip                         ' initiate recording
  LOW LEDr_                          ' record LED on

RLoop:
  GOSUB GetBtn
  IF btns = %001 THEN RLoop          ' record until release
  HIGH PD                            ' reset device
  GOTO Init

_Play:
  PAUSE 500                          ' time to release play
  HIGH PR                            ' playback mode
  GOSUB Blip                         ' initiate playback
  LOW LEDp_                          ' play LED on

PLoop:
  GOSUB GetBtn
  IF btns > %000 THEN Init           ' abort if any button pressed
  IF RecRun = Yes THEN PLoop         ' check until message done
  HIGH PD                            ' reset device
  GOTO Init

_Train:
  PAUSE 500                          ' time to release start button

  FOR delay = 1 to 280               ' 5 minute delay
    LOW LEDt_                        ' train LED on

    FOR y = 1 TO 9                   ' ~1/2 second delay
      GOSUB GetBtn                   ' - check inputs
      IF btns > %000 THEN Init       ' abort if button pressed
    NEXT

    HIGH LEDt_                       ' train LED off

    FOR y = 1 TO 9                   ' ~1/2 second delay
      GOSUB GetBtn                   ' - check inputs
      IF btns > %000 THEN Init       ' abort if button pressed
    NEXT

  NEXT ' delay

  LOW LEDt_                          ' train LED on
  FOR plays = 1 TO 100               ' play message 100 times
    HIGH PR                          ' play mode
    GOSUB Blip                       ' initiate play
    LOW LEDp_                        ' play LED on

SLoop:
    GOSUB GetBtn
    IF btns > %000 THEN Init         ' abort if any button pressed
    IF RecRun = Yes THEN SLoop       ' wait until finished playing
    HIGH PD                          ' reset the ISD
    HIGH LEDp_                       ' play LED off
    PAUSE 25
    LOW PD                           ' out of reset

    FOR y = 1 TO 500                 ' 30 second delay between plays
      GOSUB GetBtn                   ' scan buttons
      IF btns > 0 THEN Init          ' abort if button pressed
    NEXT

  NEXT

  GOTO Init                          ' reset and start over

' -----[ Subroutines ]-------------------------------------------------
'
'
Blip:
  LOW CE_                            ' initiate playback or record
  PAUSE 25
  HIGH CE_
  RETURN

' scan and debounce button inputs
' - inputs must stay low for 50 ms
' - any debounced button returns high bit in "btns"
'
GetBtn:
  btns = %0111                       ' scan record, play and wait
  FOR x = 1 TO 5
    btns = btns & ~bPort             ' check current state
    PAUSE 10
  NEXT
  RETURN
```

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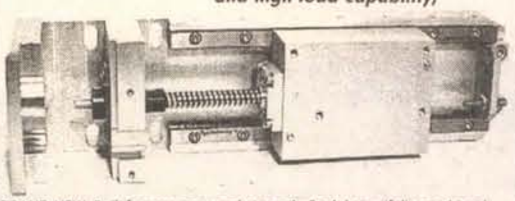

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lcd screen view

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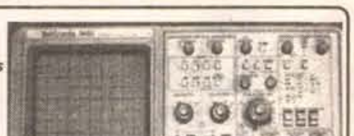

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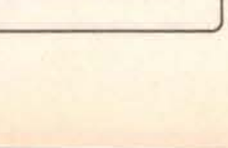

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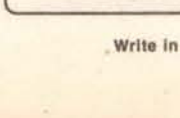

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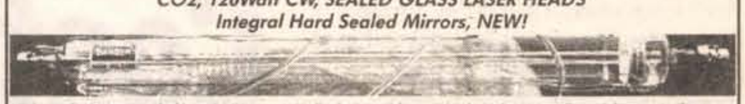

High quality water cooled heads. Were originally designed for medical application. All models are similar in construction. Size of the model 103: 60"L x 3.2"diam., Model 160: 44"L x 3.2"diam. Model 135: 35"L x 3.2"diam. Power requirement, model 103, 40KV trigger with 25KV @ 10 to 30ma operating current. Model 160 and 135, 30KV trigger with 15-20KV @ 7 to 20mA operating current. These are not toys. They must conform to Class IV CDRH regulations when assembled into a functioning system. Perfect for engraving, cutting and drilling most materials. Only three available. Only one 200W system. We don't expect any more.
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Pro System with Custom Case, BUILT-IN 12V GEL CELL, all A/V cables & charger. Super Deal. Finally we found a unit with exceptional quality at an affordable price. Perfect as a portable, general purpose color monitor for standard NTSC color or B&W video systems. Fully compatible with all our cameras as well as Camcorders, VCR's etc. Perfect as a rear view system with any video camera by virtue of its built in, mirror image function. Completely enclosed unit has adjustments for color, contrast, brightness & volume, for it's internal stereo speakers! A 1/4 x 20 Tripod socket & a tilt down stand for table top viewing. Inputs include: audio (L&R) and video on std. 1/8" mini jacks. External 12VDC on std. barrel connector. Specifications: 5.6", TFT active matrix LCD with 76.8K Pixels, CCFL backlight with 270cd/m Luminance, 500mW audio output available on std. 1/8" jack. 12V@600mA powered, 50mV min. or std. line level audio input. Size: 6.4"W x 5.25"H x 2.2D" First quality. Pro model includes: A luggage quality, custom made, padded case, dual removable straps for shoulder and/or holding at waist level for hands free viewing. Built into the case is a 12V Gel Cell, rechargeable battery plus a complete set of A/V cables. AC power adapter, power switch & charger. **GMTFT56-PRO $344ea. GMTFT56 Display only $299ea.**

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Just about every popular electronic device these days can be operated with an IR (infrared) remote control. TV sets, high-end radios, and hi-fi sets, some lights, even many ceiling fans use IR remote controls.

A wall-plug transformer provides power to the Toggle Switch, and an AC plug provides power to the controlled external device. Virtually any regular IR remote control can be used.

by Fred Blechman

Build an IR Remote Control Toggle Switch

In the early days of consumer remote controls, light, ultrasound, and radio signals were used, but they were too subject to unintended operation from interference. Light control — sometimes just a flashlight aimed at a photocell — had to be aimed at a shielded sensor or extraneous light would cause false operation. Sound had to be closely focussed and had short range, while radio signals could unknowingly trigger units in other rooms, and even travel to nearby homes. All these methods suffered from false triggering by random sources.

Modern IR remote control transmitters produce a coded stream of pulses at about 38 kiloHertz when a button is pressed. Since the IR receiver is designed to reject continuous light or non-coded light near this frequency, interference is minimized — although not completely eliminated. It is still possible, when various IR-controlled devices are in the same room, for IR remote control signals to bounce off walls and unintentionally operate equipment that has identical pulse codes.

The project we present here is simple, but useful. The "IR Remote Control Toggle Switch" is a sensitive IR pulse-code receiver that allows you to use most buttons on almost any IR remote control as the transmitter or "emitter." When a pulse-coded IR signal is received ("detected"), the Toggle Switch relay closes, and when the next pulse-coded IR signal is received, the relay opens. This "toggle" allows you to turn any electrical device (up to 200 watts) that is plugged into the Toggle Switch ON and OFF from at least 20 feet away.

Infrared Information

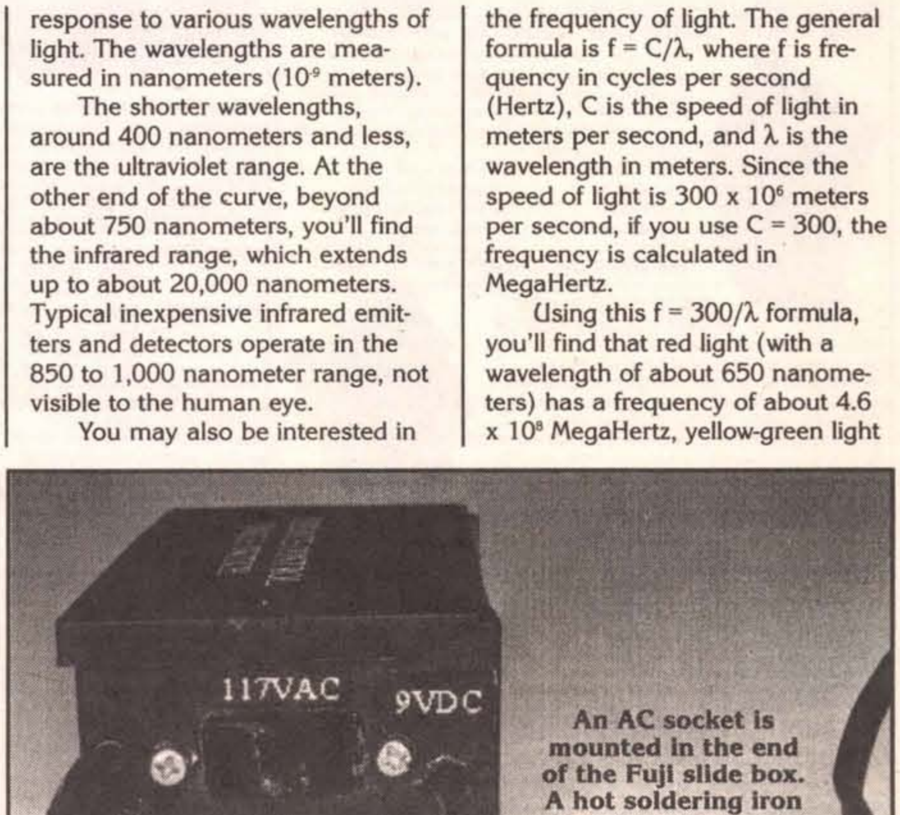
Before going any further, "infrared" should be defined. The 1931 CIE (Commission International De L'Eclairage) standard observer chart in Figure 1 (better known as the photoptic curve) shows the human eye's response to various wavelengths of light. The wavelengths are measured in nanometers (10^{-9} meters).

The shorter wavelengths, around 400 nanometers and less, are the ultraviolet range. At the other end of the curve, beyond about 750 nanometers, you'll find the infrared range, which extends up to about 20,000 nanometers. Typical inexpensive infrared emitters and detectors operate in the 850 to 1,000 nanometer range, not visible to the human eye.

You may also be interested in the frequency of light. The general formula is $f = C/\lambda$, where f is frequency in cycles per second (Hertz), C is the speed of light in meters per second, and λ is the wavelength in meters. Since the speed of light is 300 x 10^6 meters per second, if you use C = 300, the frequency is calculated in MegaHertz.

Using this $f = 300/\lambda$ formula, you'll find that red light (with a wavelength of about 650 nanometers) has a frequency of about 4.6 x 10^8 MegaHertz, yellow-green light

The Toggle Switch circuit board and an AC socket can be neatly packaged in a Fuji slide box.



An AC socket is mounted in the end of the Fuji slide box. A hot soldering iron neatly pokes holes to allow entry of the 9VDC wall-plug transformer cord and an AC line cord.

(about 570 nanometers) has a frequency of about 5.3 x 10^8 MegaHertz, and blue light (about 475 nanometers) has a frequency of about 6.3 x 10^8 MegaHertz.

In doing these calculations, pay attention to the exponents and values of the measurements in nanoseconds and MegaHertz (nano is 10^{-9} and mega is 10^6).

Project Description

If you would like to remotely turn on and off almost any electrical device from around 20 feet away, this will do the trick using almost any standard IR remote control transmitter.

When any key on most remote controls is pressed, the toggle switch relay will operate, alternately opening and closing a set of contacts. If the device to be controlled uses above 200 watts or three amperes, you can use an external power relay for the switching.

The power required to operate the toggle switch can be from 8 to 12 volts DC, with a requirement of 65 milliamperes when the relay is closed, so a typical 9V radio battery would not last long. A larger battery, or a simple wall-plug transformer in this voltage range would be the proper choice for regular use.

Circuit Operation

The schematic of the IR remote control toggle switch is shown in Figure 2. The circuit may be broken up into four parts: power, detection, toggle, and relay.

Power is regulated by zener diode Z1 and NPN transistor Q2 in combination with electrolytic capacitor C6, resistor R8, and capacitor C5. The regulated output at the emitter of Q2 is filtered from electrical "noise" by C1 and C4, and delivered to the IR module.

The IR module is an NPN phototransistor designed to detect infrared signals; the incoming infrared light acts like a signal on the base lead. The lead directly connected to power can be considered the collector, the lead connected to ground would be the emitter, and the base is biased by resistor R1.

The IR module "sees" a string of 38kHz remote control signals as a train of negative pulses, which are inverted to positive pulses by PNP transistor Q1. The positive pulses on the collector of Q1 at the top of resistor R3 charge capacitor C2 via resistor R4 and diode D1, providing a single clocking pulse to integrated circuit IC1. Resistor R5 allows C2 to discharge between commands.

Integrated circuit IC1 is a 4013 dual D flip-flop of which only one section is used. If DATA pin 5 is grounded, a positive pulse to CLK pin 3 makes pin 2 positive. Capacitor C3 charges through resistor R6 making DATA pin 5 positive. With the next clocking pulse, pin 2 goes to ground, C3 discharges, the pin 5 DATA line goes to ground, and the sequence is ready to repeat.

When pin 2 of IC1 goes positive, this voltage passes through current-limiting resistor R7 and forces NPN transistor Q3 into conduction. This effectively places the cathode of the LED and the coil of the relay at ground, so the relay contacts close and the LED lights. Resistor R9 limits the current through the LED, and diode D2 prevents damage to Q3 when the relay coil is de-energized.

So, to summarize, this is what

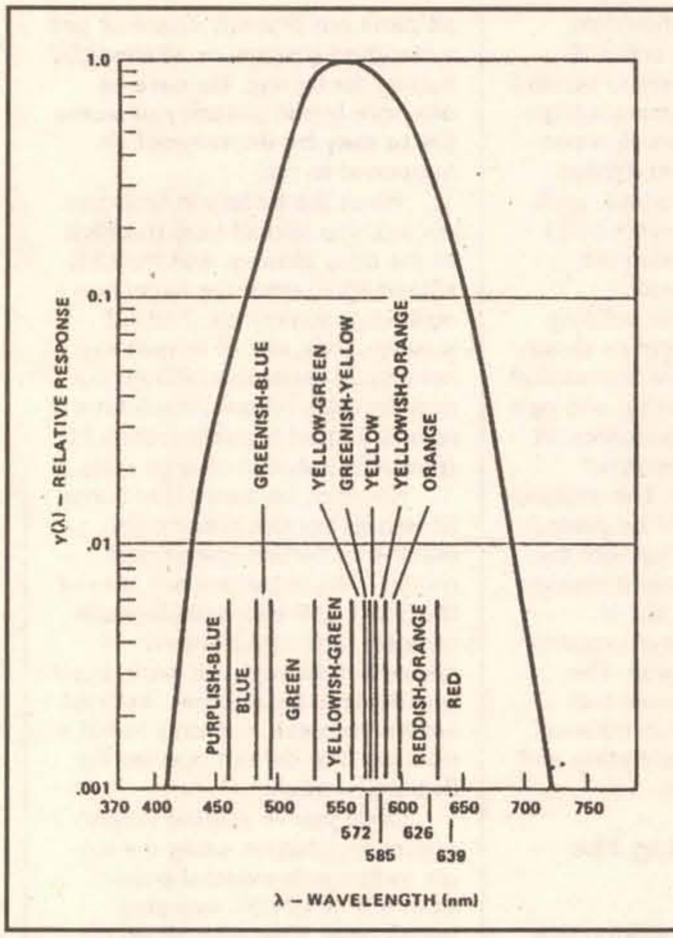


Figure 1 — Commission Internationale De L'Eclairage (CIE) Human Eye Response Curve

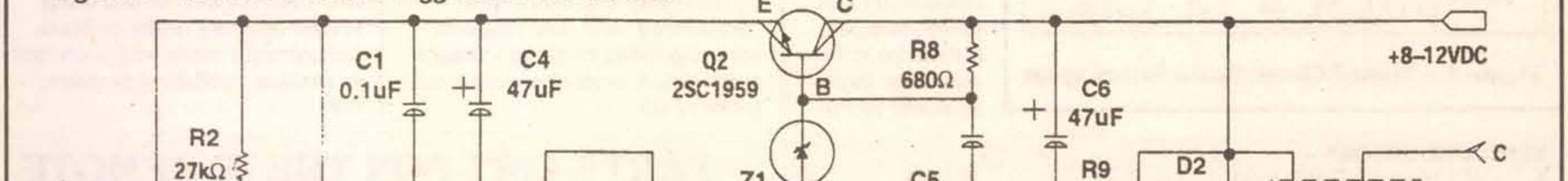
happens. When a remote control signal is detected by the IR module, IC1 receives a clocking signal that changes the state of its output pin 2. This, in turn, either turns on or releases the relay. Any external device is therefore switched on or off by the relay contacts.

Construction

Although this project can be built from available parts, it is certainly easier to build — and more likely to work — if built from the kit offered in the Parts List. This kit, made in China for RadioShack.com (formerly TechAmerica) includes some of the harder-to-find parts and an etched, drilled, and silkscreened printed circuit board. The printed circuit layout is shown in Figure 3, and the parts layout using this board is shown in Figure 4.

Some of the parts shown in the kit parts list are not exactly standard. Transistors Q1, Q2, and Q3 can be replaced with common NPN 2N3904 and PNP 2N3906 transistors. The relay in the kit has a 200 ohm coil with three amp contacts, but any relay that oper-

Figure 2 — IR Remote Control Toggle Switch Schematic



ates at six volts DC should do.

The big mystery is the IR module, which appears to be similar to a QT Optoelectronics logic detector, Digi-Key Part Number QSE156QT-ND. Other similar three-lead photo detectors, such as the RadioShack.com L14G3 phototransistor (Catalog #90-6961), should also work.

Assuming you are building the kit, locate the parts as shown in Figure 4, and follow the normal precautions for soldering and part orientation for the transistors, IR module, diodes, electrolytic capacitors, and LED. The integrated circuit, IC1, should be placed in a socket, as supplied with the kit, in case you destroy it during testing. And be sure IC1 is plugged into the socket properly, and facing the right way. The small instruction manual that comes with the kit is adequate, and includes some operating and troubleshooting hints.

Testing and Using the Toggle Switch

After carefully checking that all parts are properly oriented, use a standard (carbon or alkaline) 9V battery for testing. **Be sure to observe input polarity or some parts may be destroyed!** (It happened to us!)

When the battery is first connected, you should hear the click of the relay closing, and the LED should light, since the initial current surge makes pin 2 of IC1 positive. Now any IR remote signal should make the LED go out and the relay release. Each time a remote button is pushed, the LED (and relay) should change state.

However, be aware that some IR remote control buttons are inactive in certain operational modes. This is particularly true of the 3-in-1 or 4-in-1 multi-function remotes that control many devices. Most keys will work, but if one doesn't, try another. We tried several remotes, and only found a rare key that did not operate the IR toggle switch.

Once you've verified proper operation, plan on using the toggle switch with external power from a 9 or 12VDC wall plug transformer. That way, when the relay is closed for a long time and the power requirement is about 65 milliamperes, it won't drain the battery. You'll be connecting the NO (normally open) relay contacts to act as a switch for an external device.

Plug the toggle switch AC line cord into 117VAC, plug the DC wall transformer into power, and plug the device to be controlled (with its power switch ON) into the toggle switch socket, and you're all ready to go!

Be aware that if the device you are controlling with the toggle switch is near another IR remote controlled device, the toggle switch — which responds to a broad range of IR pulse codes — may be operated by any "invisible" IR beam bouncing off a wall or ceiling.

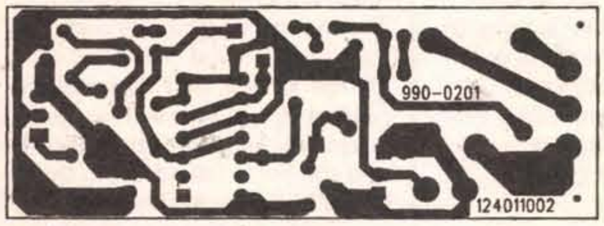


Figure 3 — Toggle Switch Printed Circuit Board Layout

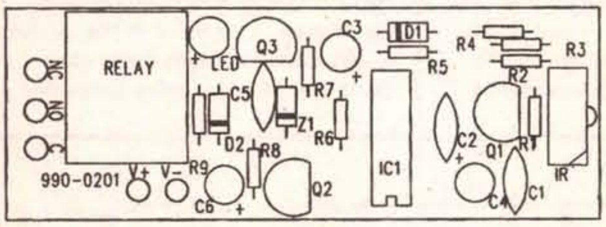


Figure 4 — Printed Circuit Board Parts Layout

Holes are made with a hot soldering iron for the IR Module and the LED "AC ON" light.

Troubleshooting

What if the LED does not go on and off, and the relay doesn't click? First, make sure the IR remote control is operating! Next check the toggle switch part orientation and solder joints. Check the input and regulated voltages; the voltage at the emitter of Q2 should be around five volts.

Still no joy? Start with the output and go back through the circuit. To check the LED and relay, use a clip lead and touch the cathode of the LED to ground; it should light and the relay should click whenever you touch ground.

To check the operation of IC1 and Q3, use a clip lead and touch the collector of Q1 to the positive side of C4. This should cause IC1 to toggle the relay and LED. Be aware that IC1 may appear erratic, since your clip lead is not "debounced" and may generate several positive clocking voltages every time it is touched to the collector of Q1.

If these tests fail, you have narrowed the search. If they pass, about the only likely suspects remaining would be the IR module or Q1. Bear in mind that the most *common* causes of failure in kit or home-built projects are bad solder joints and reversed-oriented parts.

Packaging

We installed the toggle switch in a Fuji slide box — a small black box made of thin easy-to-cut plastic, and usually available at photo stores. We mounted a 117VAC socket at one end, with a standard line cord connected to the socket through the normally open contacts of the relay.

With the line cord plugged into a regular wall socket, every time the relay closes, AC power is supplied to anything plugged into the toggle switch socket. We also brought in the leads from a 9VDC wall plug transformer and connected them to the plus and minus input terminals of the toggle switch.

At the other end of the box, we made two holes (with a hot soldering iron tip). One was for the photodetector to look through, and the other for the LED. The finished project was labeled using inverse lettering (white on black background) made with a computer desktop publishing program. **NV**

PARTS LIST FOR THE IR REMOTE CONTROL TOGGLE SWITCH

SEMICONDUCTORS
IC1 — 4013 Double D Flip-Flop
D1 — 1N4148 general-purpose small-signal switching diode
D2 — 1N4001 50-volt 1-amp silicon rectifier diode
LED — Light-emitting diode
Z1 — 1N5232B or equivalent 5.6 volt 500mW zener diode
IR Module — See text
Q1 — 2SA1015 PNP silicon transistor or equivalent (see text)
Q2, Q3 — 2SA1959 NPN silicon transistor or equivalent (see text)

RESISTORS
(All resistors are 1/4-watt 5% units.)
R1, R2, R4, R6 — 27,000 ohm
R7, R9 — 4,700 ohm
R3 — 100,000 ohm
R5 — 1 megohm
R8 — 680 ohm

CAPACITORS
C1, C2, C5 — 0.1-µF, 50-WVDC, ceramic disc
C3, C4, C6 — 47-µF, 35-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
Relay — See text
IC socket, wire, solder, printed circuit board or materials, AC socket, and a Fuji slide box or equivalent.

Note: A TechAmerica kit of all required parts, including the printed circuit board, is available as Catalog Number 990-0201 for $12.95 from Radioshack.com (P.O. Box 1981, Fort Worth, TX 76101-1981), 1-800-843-7422, or online at www.radioshack.com. There is no minimum order or small-order surcharge, and Continental USA ground shipping for this item is only $3.00.

Events CALENDAR

SEPTEMBER 2000

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

All listing information should be sent to:
Nuts & Volts Magazine
Events Calendar
430 Princeland Court
Corona, CA 92879
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

SEPTEMBER 2

CANADA - ONTARIO - CARP - Hamfest. Carp Agricultural Fairgrounds, 3970 Carp Rd. 10am-1pm. Talk-in: VE2CRA 146.940-. The Ottawa ARC, Inc., Greg Danylchenko VE3YTZ, 613-236-9291. E-Mail: fleamarket@oarc.net Web: http://oarc.net/fleamarket

NM - ALAMOGORDO - Hamfest. Alamogordo ARC, Larry Moore WA5UNO, 505-437-0145. E-Mail: n9cqoxstitch@netmdc.com

PA - UNIONTOWN - Hamfest. Uniontown ARC, Carl Chuprinko WA3HQK, 304-594-3779

TX - SULPHUR SPRINGS - Hamfest. Hopkins County ARC, Steve Heller WA0CPP, 903-945-3659. E-Mail: steve@steveheller.com Web: http://www.qsl.net/hcrc

SEPTEMBER 2-3

NC - SHELBY - Hamfest. Cleveland County Fairgrounds, US Hwy. 74. Shelby ARC, John Ledford W4JL, 704-482-4507. E-Mail: w4jl@shelby.net Web: http://www.shelby.net/n4fan

SEPTEMBER 8-9

AR - MENA - Hamfest. Queen Wilhelmina State Park, Hwy. 88. Queen Wilhelmina Hamfest Assn., Charlotte Lee KC5DOR, 870-642-7656 or 870-642-2234 ext. 107. Email: cbee48@iwon.com

SEPTEMBER 9

AR - MOUNTAIN HOME - Hamfest. Twin Lakes ARC, Miles Waldron N5QMI, 870-492-4466. E-Mail: mpwaldron@centurytel.net

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

IN - SPENCER - Hamfest. Owen County ARA, Kathryn Smith K9INU, 812-829-2140

KY - LOUISVILLE - State Convention. Bullitt County Fairgrounds. 8am-5pm. FCC exams. Greater Louisville Hamfest Assn., Herbert Rowe W4WQD, 812-294-4905. E-Mail: wd4ixl@juno.com Web: http://www.thepoint.net/~glha/

MI - GRAYLING - Hamfest. Hanson Hills Recreation Area, 7601 Old Lake Rd. 8am-12pm. VE Testing. Talk-in: 145.13. ARA of Hansen Hills, John Schultz N8YSS, 517-348-4966. E-Mail: jschultz@i2k.net Web: http://www.arahh.org/swapshop.html

MN - RUSH CITY - Hamfest. East Central MN ARC, Larry Jilek KA0MEN, 320-358-4205. E-Mail: lj@ecenet.com

NY - BALLSTON SPA - Hamfest. Saratoga County Fairgrounds. 7am-3pm. VE Testing. Talk-in: 146.40/147.00 and 147.84/147.24. Saratoga County RACES Assn., Inc., Darlene Lake N2XQG, 518-587-2385. E-Mail: lake@capital.net Web: http://www.capital.net/users/lake

WA - GRAHAM - Hamfest. RC of Tacoma, Roger Terwilliger WA7ANJ, 253-475-4293. E-Mail: rtwig@worldnet.att.net Web: http://www.w7dk.org

SEPTEMBER 9-10

FL - MELBOURNE - Hamfest. Platinum Coast ARS, Tim Madden KI4TG, 321-724-9339. E-Mail: hamfest@pcars.org

SEPTEMBER 10

MA - SOUTH DARTMOUTH - Hamfest. Southeastern MA ARA, Bill Miller K1IBR, 508-996-2969. E-Mail: billmiller@netzero.net

NY - BETHPAGE - Hamfest. Briarcliffe College, 1055 Stewart Ave. 8:30am-2pm. VE testing. Talk-in: W2VL 146.85 repeater (136.5 PL). Long Island Mobile ARC, Ed Muro KC2AYC, 516-520-9311. E-Mail: hamfest@limarc.org Web: http://www.limarc.org

OH - FINDLAY - Hamfest. Hancock County Fairgrounds. Talk-in: 147.15+, 444.15+. Findlay ARC, Bill Kelsey N8ET, 419-423-4604. E-Mail: kanga@bright.net Web: http://www.bright.net/~kanga/w8ft/hamfest.html

PA - BUTLER - Hamfest. Butler Farm Show Grounds. Talk-in: 147.360 +600. Butler County ARA, Gerald Wetzel, W3DMB, 724-282-6777. Email: w3dmb@arrl.net Web: http://www.cfcorp.com/bcara/

SEPTEMBER 15-16-17

IL - PEORIA - Hamfest. Exposition Gardens. 6am-4pm. FCC Exams. Talk-in: 147.075+, 53.990 (-1.7), and 146.76(-). Peoria Area ARC, Ron Morgan KB9NW, 309-692-3378 or 309-694-2469. E-Mail: kb9nw@juno.com Web: http://www.w9uvi.org

SEPTEMBER 16

AR - LITTLE ROCK - Hamfest. North Little Rock Community Center, 2700 North Willow St. Talk-in: 146.940-, 444.200+ (114.8 PL). CAREN, Scott Derden K5SCD, 501-258-1881. E-Mail: k5scd@arrl.net Web: http://carenclub.webjump.com

CA - SANTA ROSA - Hamfest. Lewis Adult Education Center, Corner of Lewis Rd. and Lomitas Ave. VE Session. Sonoma County RAs, Inc., Rick Reiner K6ZWB, 707-575-4455. Web: http://www.cdsl.net/scra/

GA - DALLAS - Hamfest. Paulding Meadows Park. 8am-2pm. Talk-in: 146.895+ 77Hz, 224.700-. Paulding County ARC, Inc., Bill Houston WD4LUQ, 770-445-9191. E-Mail: Bhouston@worldnet.att.net Web: http://www.pauldingarc.com/

IL - ROLLING MEADOWS - Convention. Holiday Inn Holidome, 3405 Algonquin Rd. Northern IL DX Assn., Bill Smith W9VA, 847-945-1564. Email: w9va@aol.com Web: http://www.qth.com/w9dxcc

MI - GRAND RAPIDS/CALEDONIA - Hamfest. 9757 Duncan Lk. Ave. 8am-1pm. VE Exams. Talk-in: 147.260/R, CTCSS 94.8 Hz or 146.52 simplex. Grand Rapids ARA, Lowell ARC, & MI ARA, Lee Burgess W8MLB, 616-458-9297. E-Mail: hamfest@w8dc.org Web: http://www.w8dc.org

NY - HAMBURG - Western NY ARRL Section Convention. Erie County Fairgrounds, Rt. 62. 8:30am-4:30pm. Harold Smith K2HC, 716-424-7184 E-Mail: info@buffalohamfest.org Web: http://www.buffalohamfest.org

NY - WHITE PLAINS - Hudson Division Convention. Westchester County Center. 8am-2pm. Talk-in: 147.06 PL 114.8. Westchester Emergency Communications Assn., Thomas Raffaelli WB2NHC, 914-741-6606. E-Mail: wb2nhc@weca.org Web: http://www.hudsonconvention.org

PA - BARTONSVILLE - Hamfest. Eastern Pennsylvania ARA, Tim Campson N3TIM, 570-839-3083

PA - SCHNECKSVILLE - Hamfest. Schnecksville Fire Dept. Talk-in: 146.70 (PL151.4)/R, 444.90 (PL151.4)/R. The Delaware Lehigh ARC, Inc., Carl Seier, 610-261-0403. E-Mail: aa3ix@arrl.net Web: http://www.kutztown.edu/faculty/chuk/dlarc

RI - FORESTDALE (NORTH SMITHFIELD) - Hamfest. Rhode Island Amateur FM Repeater Service, Rick Fairweather K1KYI, 401-725-7507. E-Mail: k1kyi@arrl.net

SEPTEMBER 16-17

AK - ANCHORAGE - State Convention. Ben Boeke Indoor Ice Arena. Sat: 10am-5pm, Sun: 10am-3pm. VEC Exams. Anchorage ARC, John Bury KL7QZ, 907-349-8754. E-Mail: bury@gci.net Web: http://kl7aa.akconnect.com

SEPTEMBER 17

CT - NEWTOWN - Hamfest. Edmond Town Hall, Rt. 6. 9am-2pm. Talk-in: 146.67(-) PL 100. Candlewood ARA, Seab Lyon AA1MY, 914-831-3124. E-Mail: sslyon@att.net

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

OH - CINCINNATI - Hamfest. Kolping Center. 8am-4pm. VE exams. Talk-in: 146.88-. Greater Cincinnati ARA, Jim Weaver K8JE, 513-459-0142. E-Mail: k8je@arrl.net

PA - YORK - Hamfest. York County Vo-Tech School. VEC testing. York Hamfest Foundation, John Shaffer W3SST, 717-764-8193 or 717-764-4805. E-Mail: w3sst@yorkhamfest.org Web: http://www.yorkhamfest.org

SEPTEMBER 23

AK - FAIRBANKS - Hamfest. Arctic ARC, Jim Movius KL7JM, 907-452-6347. E-Mail: ajmovius@gci.net Web: http://www.mosquitonet.com/~fbrown/00hamfest.htm

AR - BENTONVILLE - Hamfest. Shirley Harris KC5RDU, 622 Hickman Dr., Pea Ridge, AR 72751

ME - LINCOLN - Hamfest. Ella Burr School. VE Testing. Bagley ARC, Max Soucia N1KGS, 207-564-8943. E-Mail: n1kgs@arrl.net

NY - MARGARETVILLE - Hamfest. Behind the A&P. VE Exams. Talk-in: 146.520 simplex, 146.985-, 449.125-. Margaretville ARC, Lester Bourke KB2DCE, 914-586-3186 or 914-586-2324. E-Mail: bourke@catskill.net Web: http://www.catskill.net/marc

TX - WEBSTER - Hamfest. Webster Civic Center. 8am-3pm. Talk-in: 442.750+, 146.64-. Clear Lake ARC, Kyle Swarts KD5HQD, 713-666-5854. E-Mail: kd5hqd@mindspring.com Web: http://www.clarc.org/swapfest.htm

WA - WALLA WALLA - Hamfest. Walla Walla ARC, Mary Hayter KC7PNE, 509-522-5227. E-Mail: kk7sr@arrl.net

SEPTEMBER 23-24

IL - GRAYSLAKE - Hamfest. Lake County Fairgrounds, Rts. 45 & 120. Sat: 8am-4pm, Sun: 8am-3pm. VEC Testing. Talk-in: 146.16/76 MHz (107.2 Hz PL). Chicago FM Club, Mike Brost WA9FTS, 708-457-0966. E-Mail: mbrost@cin.net Web: http://www.chicagofmclub.org

VA - VIRGINIA BEACH - Roanoke Division Convention. Virginia Beach Pavilion. Sat: 9am-5pm, Sun: 9am-4pm. Talk-in: 146.970. Tidewater Radio Conventions, Art Thiemens AA4AT, 757-484-2857. E-Mail: aa4at@arrl.net Web: http://www.vahamfest.com

SEPTEMBER 24

CA - VENTURA - Hamfest. Arroyo Verde Park (Redwood Glen Area). 9am-4pm. Talk-in: 146.880 PL 127.3. Ventura County ARC, Poinsettia ARC, & SMRA 6 Meter Group, George Kreider KN6LA, 805-388-2488. E-Mail: kn6la@vcnet.com Web: http://www.jetlink.net/~ko6oy/barbq.html

FL - NEW PORT RICHEY - Hamfest. New Port Richey Recreational Center, 6630 Van Buren Rd. 9am-3pm. Suncoast ARC, Ron Wright N9EE, 727-376-6575. E-Mail: n9ee@akos.net

MD - BOWIE - Hamfest. Prince George's Stadium. VEC testing. Talk-in: 147.105, 146.529. FAR, Dan Blasberg KA8YPY, 301-345-7381. E-Mail: Blasberg@Bellatlantic.net Web: http://www.amateurradio-far.org

NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053. E-Mail: wb2slq@juno.com Web: http://www.metro70cmnetwork.com

OH - CLEVELAND - Hamfest. 8am-2pm. VE exams. Talk-in: 146.73/R PL 110.9. Hamfest Assn. of Cleveland, Ron Nichols N8LZA, 1-800-CLE-FEST or 216-999-7388. E-Mail: info@hac.org Web: http://www.hac.org

SEPTEMBER 29-30

CANADA - ONTARIO - OAKVILLE - RadioFest 2000. Monte Carlo Inn, 374 S. Service Rd. Ontario DX Assn., Brian Smith. E-Mail: odxa@compuserve.com Web: http://www.odxa.on.ca

PA - TREVOSE - Convention. The Holiday Inn Select, 4700 Street Rd. Mt. Airy VHF Radio Club, John Sortor KB3XG, 610-584-2489. E-Mail: johnkb3xg@aol.com Web: http://www.ij.net/packrats

SEPTEMBER 30

FL - DAYTONA BEACH - Hamfest. Daytona Beach ARA, Gerry Skinner K4LVZ, 904-673-0197. Web: http://dbara.org

COMPUTER SHOWS

AGI Shows, 317-299-8827.
E-Mail: info@agishows.com
http://www.agishows.com

Blue Star Productions
612-788-1901.
http://www.supercomputersale.com

Computers And You, 734-283-1754.
www.a1-supercomputersales.com

Computer Central Shows
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E-Mail: compcent@megsinet.net
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georgiamountain.com

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E-Mail: taylor@gibraltartrade.com
www.gibraltartrade.com

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KGP Productions
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E-Mail: kgp@mail.com

MarketPro, Inc., 201-825-2229.
http://www.marketpro.com

MarketPro, Inc., 301-984-0880.
E-Mail: md@marketpro.com
http://marketpro.com

Narisaam Computer Show
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E-Mail: narisaam@aol.com
Web: http://www.shownsale.com

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978-744-8440.
E-Mail: inquiries@ncshows.com
Web: ncshows.com

Peter Trapp Computer Shows
603-272-5008.
Web: www.petertrapp.com

Events CALENDAR

NY - HORSEHEADS - Hamfest. Chemung County Fairgrounds. 6am-3pm. FCC exams. Talk-in: 146.70- 444.20. ARAST, Dave Lewis, 607-589-7636. E-Mail: info@arast.org, hamfest@arast.org, or winterfest@arast.org
SD - SIOUX FALLS - Hamfest. Old National Guard Armory, Sioux Empire Fairgrounds. VE Testing. Talk-in: 146.895. Sioux Empire ARC, Will Gravning KE0Z, 605-647-2606. E-Mail: gravning@iw.net Web: http://www.qsl.net/w0zwy

OCTOBER 2000

OCTOBER 1

IA - WEST LIBERTY - Hamfest. Muscatine County Fairgrounds. VE Exams. Talk-in: 146.31/91, 146.25/85, 146.52 local. Muscatine ARC & IA City ARC, Steve Fowler KA9AQR, 309-537-3678. E-Mail: sfowler@winco.net Web: http://www.qsl.net/kc0aqs/hamfest.html
IL - DECATUR - Hamfest. Cenois ARC, Spencer Carter N9LVW, 217-692-2460. E-Mail: n9lvw@msn.com Web: http://members.tripod.com/btdad/hamfest_y2k.html
IN - BEDFORD - Hamfest. Lawrence County 4-H Fairgrounds. Hoosier Hills Ham Club, John Scheiwe KB9LTI, 812-279-0050. E-Mail: chairman@hoosierhillshamfest.org Web: http://www.hoosierhillshamfest.org
PA - WRIGHTSTOWN - Hamfest. Middletown Grange Fairgrounds, Penns Park Rd. Pack Rats, Joe Keer KU3T, E-Mail: ku3t@amsat.org Web: http://www.ij.net/packrats
WA - CHEHALIS - Hamfest. The Southwest Washington Fairgrounds. Talk-in: 147.06+ PL 110.9, 146.46 simplex. Chehalis Valley ARS, James Kruger KK7AB, 360-748-1930. E-Mail: teaser@localaccess.com Web: http://www2.localaccess.com/teaser/cvars/

OCTOBER 6-7

NH - ROCHESTER - Hamfest. Fairgrounds. Hoss Traders, Joe Demaso K1RQG, 207-469-3492. E-Mail: k1rqg@aol.com Web: http://www.qsl.net/k1rqg

OCTOBER 6-7-8

AZ - SCOTTSDALE - Southwestern Div. Convention. Ramada Inn Valley Ho, 6850 Main St. Scottsdale ARC, Walt Schuknecht N7IZM, 480-947-0338. E-Mail: n7izm@arrl.net Web: http://www.w7asc.org/swdc2000
OK - BROKEN ARROW - Hamfest. Broken Arrow ARC, Joe Horn KC5VPO, 918-451-0028. Web: http://www.qsl.net/w5bbs/hamfest

OCTOBER 7

FL - ORLANDO - Hamfest. Bahia Temple, 2300 Prembrook Dr. Talk-in: 147.390. Ed KY4E, 407-660-0936. E-Mail: ky4e@excite.com
MO - WARRENSBURG - Hamfest. Warrensburg Area ARC, Denise Haye N0PVS, 816-697-3426. E-Mail: we0g@microlink.net Web: http://www.call.to/waarci
NJ - TEANECK - Hamfest. Fairleigh Dickinson University. 8am-2pm. FCC Exams. Talk-in: 146.19/79 and 146.52 simplex. Bergen ARA, Jim Joyce K2ZO, 201-664-6725. E-Mail: jjjoyce@cybernex.net Web: http://www.bara.org
PA - LANCASTER COUNTY - Hamfest. West Earl Community Park, Rt. 772. 8am-2pm. Talk-in: 147.015 PL 118.8. Red Rose Repeater Assn., Pat Bouder KA3FGH, 717-626-7539. E-Mail: rbouder-pat@redrose.net

OCTOBER 8

CT - WALLINGFORD - State Convention. Mountainside Special Event Facility. 9am-3pm. Talk-in: 147.36/96. Nutmeg Hamfest Alliance, Gordon Barker K1BIY, 860-342-3258. E-Mail: k1biy@juno.com Web: http://www.qsl.net/nutmeghamfest
MD - WEST FRIENDSHIP - Hamfest. Columbia ARA, Randy Krenz N3HFK, 410-796-2587. E-Mail: n3hfk@arrl.net Web: http://www.qsl.net/cara
MI - DIMONDALE - Hamfest. The Summit, 9410 Davis Hwy. 8am-2pm. VE testing. Talk-in: 145.390 (-600) and 146.520. Central MI ARC & Lansing Civil Defense Repeater Assn., J. Ervin Bates W8ERV, 517-676-2710. E-Mail: w8erv@arrl.net Web: http://www.qsl.net/CMARC/hamfair.html
OH - MEDINA - Hamfest. National Guard Armory, 920 Lafayette Rd. 8am-2pm. Medina Two Meter Group, Michael Rubaszewski N8TZY, 330-273-1519. E-Mail: n8tzy@webcombo.net Web: http://www.qsl.net/m2m

OCTOBER 13-14

FL - WALDO - Hamfest. Dixieland Music Park. Talk-in: 145.150-. Bradford Area ARC, John Bradley KU4AY, 904-782-1185. E-Mail: jbradley@techcomm.net Web: http://www.angelfire.com/fl/arcba/index.html

OCTOBER 14

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
FL - TAMPA - Hamfest. Egypt Temple Complex, 4050 Dana Shores Dr. 8am-5pm. Talk-in: 146.940. Egypt Shrine Temple AR, Jay Strom K9BSL, 727-822-9107. E-Mail: k9bsl@juno.com
GA - AUGUSTA - Hamfest. Westside High School. 9am-3pm. Talk-in: 145.490. ARC of Augusta, Henry KN4AV, 706-793-1625. Email: kn4av@bellsouth.net or w4dv@arrl.net
MT - BOZEMAN - Hamfest. Gallatin Ham RC, Don Wilson KC7EWZ, 406-586-6659. E-Mail: nandon@mcn.net
ND - GRAND FORKS - Hamfest. Forks ARC, Steve DuFault KB0QQE, 218-281-7875. E-Mail: kb0qqe@rrv.net
NJ - LEONARDO - Hamfest. Croydon Hall. VE testing. Talk-in: 145.485 -6, 151.4. Garden State ARA, Mario Sellitti N2PVP, 732-787-7184. E-Mail: gsara@arrl.net Web: http://www.monmouth.com/~gsara
TX - DENTON - North Texas Section Convention. Denton Civic Center, 321 E. McKinney St. 7am-3pm. Talk-in: 146.92 (PL 110.9). Denton County ARA, William Spradling WA5I, 817-441-1170. E-Mail: wa5i@aol.com Web: http://www.dmathis@lsic.net
VA - STAFFORD - Hamfest. Mt. Ararat Baptist Church parking lot. 8am-3pm. Talk-in: 145.27. Stafford ARA, Richard Diddams KF6UTH, 540-657-8322. E-Mail: rldiddams@earthlink.net Web: http://www.n4nw.org
WA - BREMERTON - Hamfest. County Fairgrounds, President's Hall, NW corner of Fairgrounds Rd. at Nels Nelson Rd. 9am-2pm. Talk-in: 146.620- 103.5, 146.520 simplex. North Kitsap ARC, Susan Johnson AB7MD, 360-697-9379. E-Mail: nkarc@yahoo.com Web: http://www.silverlink.net/nkarc

OCTOBER 15

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html
MI - KALAMAZOO - Hamfest. Kalamazoo County Fairgrounds. VE Testing. Talk-in: 147.040.

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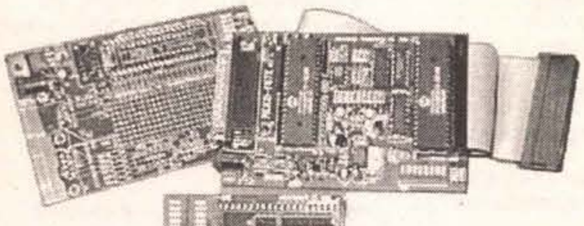

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supports 16F87x, 16C66/67/76/77

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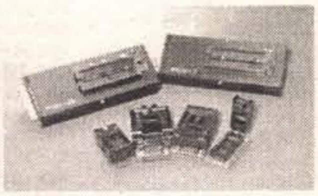
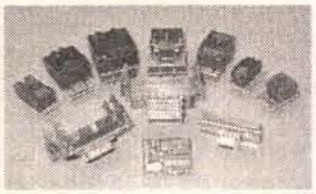
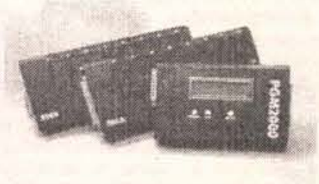

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Kalamazoo ARC & Southwest Michigan AR Team, Charlie Burgstahler K8BLO.
E-Mail: charlieb@net-link.net
Web: http://www.qsl.net/k8blo/hamfest.htm
NY - QUEENS - Hamfest. NY Hall of Science parking lot, Flushing Meadow Corona Park, 47-01 111th St. VE exams. Talk-in: 444.200 repeat, PL 136.5, 146.52 simplex. The Hall of Science ARC, Stephen Greenbaum WB2KDG, 718-898-5599, eves only. E-Mail: WB2KDG@Bigfoot.com or Andy Borrok N2TZX, 718-291-2561. E-Mail: N2TZX@webspan.net
OH - ASHLAND - Hamfest. Ashland Area ARC, David Fike N8UCA, 419-289-1082.
E-Mail: aaarc@neo.rr.com
OH - LIMA - Hamfest. Northwest Ohio ARC, Greg Schwark N8WBD, 419-647-6321 or 419-647-5127.
E-Mail: gas1950@aol.com

OCTOBER 20-21-22

CA - CONCORD - Pacific Division Convention. Sheraton Concord (Airport) Hotel. Mt. Diablo ARC, Terry Matzkin KE6WRE, 925-820-5848.
Web: http://www.pacificon.org

OCTOBER 21

CT - WATERFORD - Auction. Senior Citizens Center, Waterford Municipal Complex, Rt. 85. Talk-in: 146.97. Tri-City ARC, Austin J. Wolfe AA1SV, 860-443-2459.
E-Mail: aa1sv@downcity.net
IL - GODFREY - Hamfest. Lewis & Clark RC, Larry Roberts W9MXC, 314-233-3499.
E-Mail: lhrob@home.com
LA - LAKE CHARLES - Hamfest. Lake Charles SW LA ARC, Joe Czejkowski WE5V, 337-855-9202. E-Mail: joeczejk@juno.com
NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665
OR - RICKREALL - Convention. Polk County Fairgrounds. 9am-3:30pm. Talk-in: 146.86. Mid-Valley ARES, Bud Smith WA7FJF 503-838-0266.
E-Mail: to wa7fjf@arrl.net Web: http://www.teleport.com/~n7ifj/swaptobe.htm
TN - GRAY - Hamfest. Appalachian Fairgrounds, off I-181. Kingsport, Bristol, and Johnson City Radio Clubs, Wendell Messimer K4ZHK, POB 3682 CRS, Johnson City, TN 37602

OCTOBER 22

MD - WESTMINSTER - Hamfest. Carroll County Agricultural Center. Talk-in: 145.410(-). The Carroll County ARC, Inc., E-Mail: w3jjh@arrl.net
Web: http://www.qis.net/~k3pzn
MI - WARREN - Hamfest. Italian American Cultural Center, 28111 Imperial Dr. 8am-1pm. VE Testing. Talk-in: 147.180+/ PL 100 Hz. Utica Shelby Emergency Communications Assn., Dave Cunningham KC8IAQ, 810-263-0227.
E-Mail: kc8iaq@att.net Web: http://members.home.net/dougk/useca.htm
NY - FARMINGDALE - Hamfest. Radio Central ARC, Neil Heft KC2KY, 631-737-0019.
E-Mail: nheft@attglobal.net
Web: http://www.rcarc.org/expo.htm
PA - SELLERSVILLE - Hamfest. Sellersville Fire House, Rt. 152. VE Session. Talk-in: 145.31. RF Hill ARC, Linda Erdman KA3TJZ, 215-679-5764.
Web: http://www.rfhill.ampr.org

OCTOBER 27-28

OK - KINGSTON - Hamfest. Lake Texoma Lodge, Hwy. 70. Texoma Hamarama Assn., Herb Sleeper WB5PHM, 940-855-5820.
E-Mail: retmarine@cst.net

OCTOBER 28

CANADA - QUEBEC - MONTREAL - Hamfest. Montreal South ARC, Micheline Simard VE2XW, 450-446-0477. E-Mail: ve2xw@amsat.org
FL - JACKSONVILLE - Hamfest. Morocco Shrine Auditorium, 3800 S. St. Johns Bluff Rd. 9am-9pm. Talk-in: 146.76 and 146.88. Greater Jacksonville Hamfest Assn., Jeff Greer WD4ET, 904-613-7427 or Deborah Lusk KG4ADZ, 904-739-9713. Web: http://www.ccse.net/~lrich/JAXHAMFEST.html
MN - ST. PAUL - Hamfest. RiverCentre. 8am-4pm. VE exams. Twin Cities FM Club, Amanda Roberts KG0AY, 612-535-0637.
E-Mail: kg0ay@pclink.com
Web: http://www.hamfestmn.org
MO - ST. LOUIS - Hamfest. Kirkwood Community Center, 111 N. Geyer Rd. 8am-2pm. VE exams. Talk-in: 146.91-. St. Louis ARC & Gateway to Ham RC, Steve Welton WB0IUN, 314-638-4959. E-Mail: slw@partyline.net
SC - SUMTER - Hamfest. Sumter ARA, Thomas D'Anella KC4ZTC, 803-499-4806. E-Mail: dstoy@sumter.net Web: http://www.geocities.com/capecanaveral/2695/sara.htm
TN - EAST RIDGE - Hamfest. Camp Jordan Arena. 8am-4pm. VE exams. Talk-in: 146.79- & 444.1+. Chattanooga ARC, David Hoffman KE4FGW, 423-877-7398. E-Mail: ke4fgw@vol.com
Web: http://www.qsl.net/w4am/carc_index.html

OCTOBER 28-29

FL - UMATILLA - Hamfest. Lake ARA, John Gable W8KCE, 352-394-2723.
E-Mail: w8kce@aol.com
TX - EL PASO - Int'l Hamfiesta. Clay Emert K5TRW, 915-859-5502

OCTOBER 29

IA - DES MOINES - Hamfest. Tikva Tracers ARC & Iowa Assn., of ARCs, Rod Ivers KI0BW, 515-276-0500 or 515-278-9945. E-Mail: ki0bw@arrl.net
NY - LINDENHURST - Hamfest. Knights of Columbus Hall, 400 S. Broadway. 9am-2pm. GSBARC & SCRC, Lenore Dunlop N2KYP, 516-785-0826. E-Mail: info@gsbarc.org
Web: http://www.gsbarc.org
OH - CANTON - Hamfest. Stark County Fairgrounds. Talk-in: 147.18+. The Massillon ARC. Email: marc.hamclub@juno.com Web: www.qsl.net/w8np
OH - MARION - Hamfest. Marion ARC, Karen Eckard N8KE, 740-499-3565.
E-Mail: meeker@gte.net
PA - CARLISLE - Hamfest. Carlisle Fairgrounds. 8am-3pm. Talk-in: 145.430. South Mountain Repeater Assn., Bill Smyser, 717-532-9870. E-Mail: smraham@aol.com Web: www.qsl.net/kb3cvo

NOVEMBER 2000

NOVEMBER 4

FL - SORRENTO - Hamfest. Lake ARA, John Gable W8KCE, 352-394-2723.
E-Mail: w8kce@aol.com
NM - SOCORRO - Hamfest. Socorro ARA, Tech ARA, & City of Socorro, Al Braun AC5BX, 505-835-3370. E-Mail: ac5bx@juno.com
Web: http://www.ees.nmt.edu/sara/
OK - ENID - Hamfest. Garfield County Fairgrounds, Hoover Bldg. 8am-5pm. Talk-in: 147.15+, 444.40+. Enid ARC, Tom Worth N5LWT, 580-233-8473; Email: n5lwt@hotmail.com or Fred Selfridge WA5OU, 580-242-3551

NOVEMBER 4-5

GA - LAWRENCEVILLE - Hamfest. Gwinnett County Fairgrounds. Sat: 9am-5pm, Sun: 9am-3pm. Talk-in: 145.45- (PL107.2), 444.25+ (PL131.8), 146.76- (PL107.2). Alford Memorial RC, 770-410-3989. E-Mail: KR4NQ@bigfoot.com
Web: www.totr.radio.org

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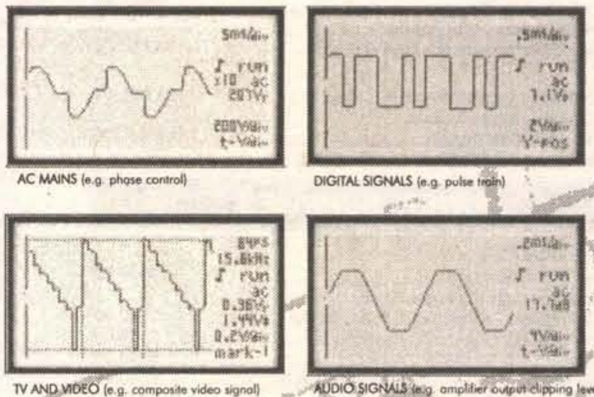
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WAVEFORM GENERATORS

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HP 3310A 5 MHz Function Generator ... **$250.00**
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TEK AWG5102 Arb.Waveform Gen., 20 MS/s,12 bits,50ppm synthesis <1MHz ... **$650.00**
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TEK FG502 11 MHz Function Generator, TM500 series ... **$275.00**
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TEK RG501 Ramp Generator, TM500 series ... **$175.00**
WAVETEK 288 20 MHz Synthesized Function Generator, GPIB ... **$650.00**

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CURRENT METERS & SOURCES

HP 6181C DC Current Source, to 100 V, 250 mA ... **$500.00**
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HP 5315A-003 100 MHz/100 nS Univ. Counter, 1 GHz C-channel option ... **$450.00**
HP 5316A 100 MHz/100 nS Universal Counter, HPIB ... **$450.00**
HP 5316B 100 MHz/ 100 nS Universal Counter, HPIB ... **$550.00**
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HP 5386A-004 3 GHz Frequency Counter, HPIB; OCXO reference option ... **$1,000.00**

MISCELLANEOUS

HP 105B Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz, battery power ... **$1,100.00**
HP 5087A-opt.032 Distribution Amplifier, 12 outputs at 5 MHz ... **$1,750.00**

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SPECTRUM ANALYSIS

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HP 8903A Audio Analyzer, 20 Hz-100 kHz ... **$1,200.00**

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HP 467A Power Amplifier, X1/X2/X5/X10, DC-1 MHz, 10 W output ... **$375.00**
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KROHN-HITE 3200 High Pass / Low Pass Filter, 20 Hz-2 MHz, 24 dB/octave ... **$275.00**
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HP 8559A/853A-001 Spectrum An., $3,500.00
0.01-21 GHz, 1 kHz res.,w/rackmount frame
HP 85640A Tracking Generator, $5,000.00
300 kHz-2.9 GHz, for HP 8560 series
HP 8568B Spectrum Analyzer, $8,500.00
100 Hz-1.5 GHz, 10 Hz min. res.
HP 8569B Spectrum Analyzer, $5,500.00
10 MHz-22 GHz, 100 Hz min.res.bw.
TEK 492-opt.02 Spectrum Analyzer, $4,250.00
50 kHz-18 GHz, 1 kHz res.
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz $1,500.00

NETWORK ANALYZERS

HP 11650A Network Analyzer Accessory Kit, APC7 $600.00
HP 11665B Modulator, 0.15-18 GHz, for HP 8755/6/7 $250.00
HP 85054A Type N Calibration Kit, for HP 8510 series $1,800.00
HP 8511A Frequency Converter, $6,500.00
45 MHz-26.5 GHz, for HP 8510
HP 8717A Transistor Bias Supply $500.00
HP R85026A WR28 Detector, $1,200.00
26.5-40 GHz, for HP 8757 series

SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., $1,650.00
0.1-1050 MHz, 10 Hz res., GPIB
FLUKE 6060A/AN Synthesized $950.00
Signal Generator, 10 kHz-520 MHz, 10 Hz res
FLUKE 6060B/AK Synthesized Signal Gen., $1,900.00
0.1-1050 MHz, 10 Hz res.
FLUKE 6062A Synthesized Signal Gen., $4,000.00
100 kHz-2.1 GHz, 100 Hz res.
GIGATRONICS 600/6-12 Synthesized $2,500.00
Source, 6-12 GHz, 1 kHz res., GPIB
GIGATRONICS 6000/8-16 $2,250.00
Synthesized CW Gen., 8-16 GHz, 1 MHz res., +10 dBm $2,500.00
GIGATRONICS 875/50 Levelled
Multiplier, x4, 50.0-75.0 GHz output, -3 dBm
GIGATRONICS 900/2-8 Synthesized $2,500.00
Signal/Sweep Gen., 2-8 GHz, 1 MHz res.,GPIB
HP 11707A Test Plug-in for HP 8660 series $500.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio $450.00
HP 3335A-001 Synthesizer/ Level Gen., $3,500.00
200 Hz-81 MHz, -87 to +13 dBm
HP 8656A-001 Signal Generator, $1,600.00
0.1-990 MHz, 100 Hz res., HPIB, OCXO
HP 8657A-002 Signal Generator, $2,750.00
0.1-1040 MHz, 10 Hz res., HPIB
HP 8671B Synthesized CW Gen., $4,250.00
2-18 GHz, 1-3 kHz res., +8 dBm
HP 8672A Synthesized Signal $4,500.00
Generator, 2-18 GHz, +3 dBm output
HP 8684B Signal Generator, $3,000.00
5.4-12.5 GHz, AM/ WBFM/ Pulse

SWEEP GENERATORS

HP 8350B/83522A Sweep Oscillator, $3,900.00
10-2400 MHz, +13 dBm levelled
HP 8350B/83540A-002,004 Sweep $3,900.00
Oscillator, 2.0-8.4 GHz, 70 dB step attenuator
HP 8350B/83545A-002 Sweep Oscillator, $3,900.00
5.9-12.4 GHz, 70 dB step attenuator
HP 83570A RF Plug-in, $6,000.00
18.0-26.5 GHz, +10 dBm levelled
HP 83592B RF Plug-in, $8,000.00
10 MHz-20 GHz, +13 dBm levelled
HP 8601A Generator/Sweeper, $400.00
0.1-110 MHz, +20 dBm levelled
HP 8620C Sweep Oscillator Frame $550.00
HP 86222A RF Plug-in, $1,000.00
10-2400 MHz, +13 dBm levelled
HP 86222B RF Plug-in, 10-2400 MHz, $1,200.00
+13 dBm lvld., crystal markers
HP 86222B-002 RF Plug-in, $1,350.00
10-2400 MHz, +13 dBm lvld., 70 dB step att.
HP 86222B-E69/8620C Sweep $1,500.00
Oscillator,0.01-2 GHz & 2-4 GHz, +10 dBm, w/frame
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled $300.00
HP 86240A RF Plug-in, 2.0-8.4 GHz, +16 dBm unlevelled $400.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $300.00
HP 86260A-H04 RF Plug-in, $400.00
10.0-15.0 GHz, +10 dBm unlevelled
HP 86290C RF Plug-in, $1,850.00
2.0-18.6 GHz, +13 dBm levelled output
WAVETEK 962 Sweep Generator, $950.00
1.0-4.0 GHz, markers, +12 dBm unlvld.

POWER METERS

BOONTON 42B/41-4E Analog Power Meter, $450.00
with 1 MHz-18 GHz sensor
HP 432A/478A Power Meter, $300.00
-30 to +10 dBm, 10 MHz-10 GHz
HP 435B/8481A Power Meter, $900.00
-30 to +20 dBm, 10 MHz-18 GHz
HP 435B/8482B Power Meter, $1,500.00
0 to +43 dBm, 100 kHz-4.2 GHz
HP 436A-022/8481A Power Meter, $1,200.00
-30 to +20 dBm, 10 MHz-18 GHz, HPIB
HP 436A-022/8484A Power Meter, $1,200.00
-70 to -20 dBm, 10 MHz-18 GHz, HPIB
HP Q8486A Power Sensor, $1,200.00
33.0-50.0 GHz, WR22, for 435/6/7/8
HP R8486A WR28 Power Sensor, $1,500.00
26.5-40 GHz, for HP 435/6/7/8

RF MILLIVOLTMETERS

BOONTON 92C RF Millivoltmeter, $500.00
3 mV-3 V f.s., 10 kHz-1.2 GHz
RACAL-DANA 9303 RF Millivoltmeter, $750.00
10 kHz-2 GHz, -70 to +20 dBm

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 4W1000 $950.00
Amplifier, 40 dB gain, 4 Watts, 1-1000 MHz
HP 11729B-003 Carrier Noise Test Set, 5 MHz-3.2 GHz $2,250.00
HP 415E SWR Meter $200.00
HP 8406A Comb Generator, $500.00
1/ 10/ 100 MHz increments, to 5 GHz
HP 8447A Amplifier, 20 dB, $375.00
0.1-400 MHz, 5 dB NF, +6 dBm output
HP 8447E Amplifier, 22 dB, $750.00
0.1-1300 MHz, +13 dBm output
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz $1,500.00
HP 8901B-1,2,3 Modulation An., $2,000.00
0.15-1300 MHz, rear input, OCXO, ext.LO
HUGHES 1177H01F000 TWT $1,750.00
Amplifier, >30 dB gain, 2-4 GHz, 10 Watts output
HUGHES 1177H10F000 TWT $2,500.00
Amplifier, >30 dB gain, 1.4-2.4 GHz, 20 Watts
HUGHES 8010H13F000 TWT $2,500.00
Amplifier, >30 dB gain, 3-8 GHz, 10 Watts
RF POWER LABS ML50 Amplifier, $275.00
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ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz $3,750.00

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AMERICAN NUCLEONICS AM-432 $95.00
Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW*
AVANTEK AMT-400X2 WR28 Active $450.00
Doubler, +10 dBm in/ +10 dBm out 26-40 GHz
BIRD 6735-300 1 kW Load, 25-1000 MHz, LC(f), with wattmeter $650.00
BIRD 8201 500 Watt Oil Dielectric Load, DC-2.5 GHz, N(f) $350.00
FXR/MICROLAB S3-02N Triple $125.00
Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f)
FXR/MICROLAB SL-03N Stub Stretcher, $75.00
0.3-6.0 GHz, 100 Watts max., N(m/f)
GR 874-LTL Constant Impedance $400.00
Trombone Line, 0-44 cm, DC-2 GHz
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 $450.00
HP 11636A 2-Way Power Divider, DC-18 GHz, N(m/f/f) $300.00
HP 11691D-001 Directional Coupler, $450.00
22 dB, 2-18 GHz, N(f)-all ports
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz $800.00
HP 33321K Programmable Step Atten., $475.00
0-70 dB, DC-26.5 GHz, 3.5mm
HP 33327L-006 Programmable $1,000.00
Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz $275.00
HP 776D Dual Directional Coupler, 20 dB, 940-1900 MHz $275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz $275.00
HP 778D-011 Dual Dir. Coupler, $450.00
20 dB, 100-2000 MHz, APC7 test port
HP 8431A 2-4 GHz Band Pass Filter, N(m/f) $150.00
HP 8494G-002 Programmable Step $350.00
Attenuator, 0-11 dB, DC-4 GHz, SMA
HP 8496A-002 Step Attenuator, 0-110 dB, DC-4 GHz, SMA $375.00
HP 8497K-004 Programmable $750.00
Step Attenuator, 0-90 dB, DC-26.5 GHz
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz $450.00
HP K752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz $300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz $650.00
HP R347B WR28 Noise Source, 10-13 dB ENR $1,650.00
HP R422A WR28 Crystal Detector, 26.5-40 GHz $400.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz $250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz $750.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz $650.00
HP X870A WR90 Slide Screw Tuner $150.00
HUGHES 45322H-1110/1120 WR22 $350.00
Directional Couplers, 10 or 20 dB, 33-50 GHz
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz $750.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz $900.00
HUGHES 45721H-2000 WR28 $1,000.00
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HUGHES 45722H-1000 WR22 Direct $1,000.00
Reading Attenuator, 0-50 dB, 33-50 GHz
HUGHES 45724H-1000 WR15 $1,000.00
Direct Reading Attenuator, 0-50 dB, 50-75 GHz
HUGHES 45732H-1200 WR22 $250.00
Level Set Attenuator, 0-25 dB, 33-50 GHz
HUGHES 45752H-1000 WR22 $1,400.00
Direct Reading Phase Shifter, 0-360 deg.,33-50 GHz
HUGHES 45772H-1100 WR22 $400.00
Thermistor Mount, -20 to +10 dBm, 33-50 GHz
HUGHES 45773H-1100 WR19 $650.00
Thermistor Mount, -20 to +10 dBm, 40-60 GHz
HUGHES 45774H-1100 WR15 $750.00
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HUGHES 47316H-1111 WR10 Tuneable $600.00
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Locked Gunn Osc., 32.000 GHz, +18 dBm
HUGHES 47742H-1210 WR22 $2,750.00
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KRYTAR 201020010 Directional $200.00
Detector, 1-20 GHz, SMA(f/f)/SMC
KRYTAR 2616S Directional $200.00
Detector, 1.7-26.5 GHz, K(f/m)/SMC
M/A-COM 3-19-300/10 WR19 $450.00
Directional Coupler, 10 dB, 40-60 GHz
MICA C-121S06 Circulator, 17.5-24.5 GHz, SMA(f/m/m) $75.00
MINI-CIRCUITS ZFDC-20-4 $25.00
Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f)
NARDA 3000-SERIES Directional Couplers $150.00
NARDA 3020A Bi-Directional Coupler, 50-1000 MHz, N $475.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz $375.00
NARDA 3090-SERIES Precision High Directivity Couplers $225.00
NARDA 368BNM Coaxial High Power $500.00
Load, 500 Watts, 2.0-18 GHz, N(m)
NARDA 3752 Coaxial Phase Shifter, $1,000.00
0-180 deg./GHz, 1-5 GHz
NARDA 3753B Coaxial Phase Shifter, $1,000.00
0-55 deg./GHz, 3.5-12.4 GHz
NARDA 4000-SERIES SMA Miniature Directional Couplers $75.00
NARDA 4227-16 Directional Coupler, $325.00
16 dB, 1.7-26.5 GHz, 3.5mm(f)
NARDA 4242-20 Directional Coupler, $100.00
20 dB, 0.5-2.0 GHz, SMA(f)
NARDA 4247-20 Directional Coupler, $200.00
20 dB, 6.0-26.5 GHz, 3.5mm(f)
NARDA 4247B-10 Directional Coupler, $200.00
10 dB, 6.0-26.5 GHz, 3.5mm(f)
NARDA 5070-SERIES Precision Reflectometer Couplers $300.00
NARDA 562 DC Block, $65.00
10 MHz-12.4 GHz, 100 V max., N(m/f)
NARDA 765-10 10 dB Attenuator, 50 Watts, $165.00
DC-5 GHz, N(m/f)
NARDA 791FM Variable Attenuator, 0-37 dB, 2.0-12.4 GHz $600.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz $375.00
NARDA 793FM Direct Reading $225.00
Variable Attenuator, 0-20 dB, 4-8 GHz
NARDA 794FM Direct Reading $375.00
Variable Attenuator, 0-40 dB, 4-8 GHz
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Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f)
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Circulator, 18.0-26.5 GHz
SONOMA SCIENTIFIC 21A3 $75.00
WR42 Circulator, 20 dB, 20.6-24.8 GHz
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0-79 dB, DC-1 GHz, AC or DC coupled
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Attenuator, 0-50 dB, 33-50 GHz
TRG V510 WR15 Direct Reading $900.00
Attenuator, 0-50 dB, 50-75 GHz
TRG V551 WR15 Frequency Meter, 50-75 GHz $600.00
TRG W510 WR10 Direct Reading $1,000.00
Attenuator, 0-50 dB, 75-110 GHz
TRG W551 WR10 Frequency Meter, 75-110 GHz $750.00
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HP 59401A HPIB Bus Analyzer $375.00
MICRODYNE 1200MR 215-320 MHz $450.00
Telemetry Receiver, PSK demodulation
TEK 1411R PAL Gen.,w/SPG12 sync; $750.00
TSG11 color bars;TSG13 linearity
TEK 1411R PAL Test Gen., $1,000.00
w/SPG12,TSG11,TSG13,TSG15,TSG16
TEK 1411R PAL Test Gen., $1,100.00
w/SPG12,TSG11,TSG12,TSG13,TSG15,TSG16
TEK 1411R-opt.04 PAL Test Gen.,w/
SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 $1,400.00
TEK 147A NTSC Test Signal $800.00
Generator, with noise test signal
TEK 148 PAL Insertion Test Signal Generator $700.00
TEK 520A NTSC Vectorscope $750.00
TEK 521A PAL Vectorscope $750.00

MISCELLANEOUS

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TEK TM504 500-series 4-slot Power Module $175.00
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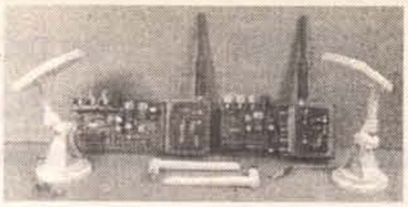
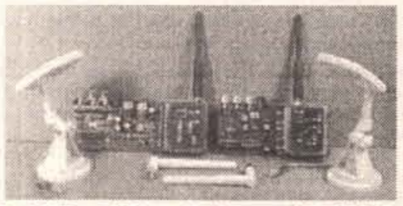


1.2GHz ATV — 8 channel TRANSMITTERS and RECEIVERS. 75mW output power, 1 video channel, 2 audio. SMA connectors. NTSC/PAL compatible. Includes 1/4 wave rubber duck antenna. Standard frequencies are: 1250, 1255, 1260, 1265, 1270, 1275, 1280, 1290 MHz. Custom frequencies are available. **$79/each for transmitter. $79/each for receiver.** Seabrook, 972-480-0060 (Texas, 9-6PM CST). E-Mail: main@480i.com Web: www.480i.com



2.4GHz ATV — 8 channel TRANSMITTERS AND RECEIVERS. 35mW output power, 1 video channel, 2 audio. SMA connectors. NTSC/PAL compatible. Includes 1/4 wave rubber duck antenna. Standard frequencies are: 2398, 2405, 2412, 2416, 2420, 2428, 2435, 2442 MHz. Custom frequencies are available. See ad in this section for power amplifier. **$79/each for transmitter. $79/each for receiver.** Seabrook, 972-480-0060 (Texas, CST) or E-Mail: main@480i.com Web: www.480i.com

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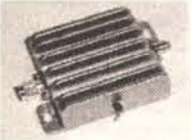
WANTED: ROCKWELL-Collins HF-80 equipment, 851S-1, 237B-3 log periodic, Collins literature. Jim Stitzinger 805-259-2011, 805-259-3830 (fax), bfl-jfs@smartlink.net



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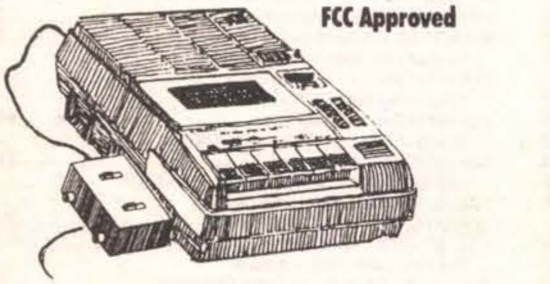

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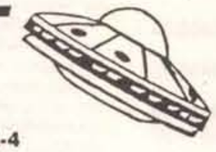

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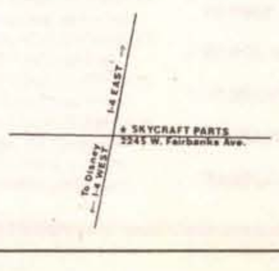

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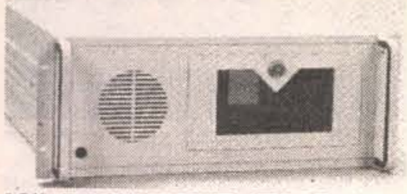

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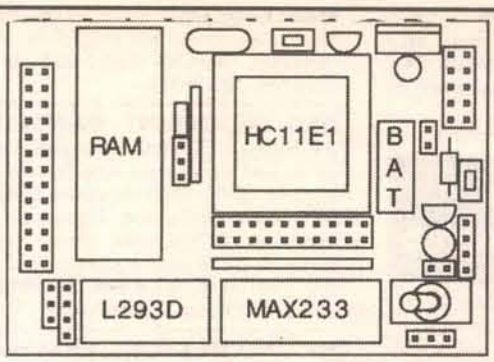

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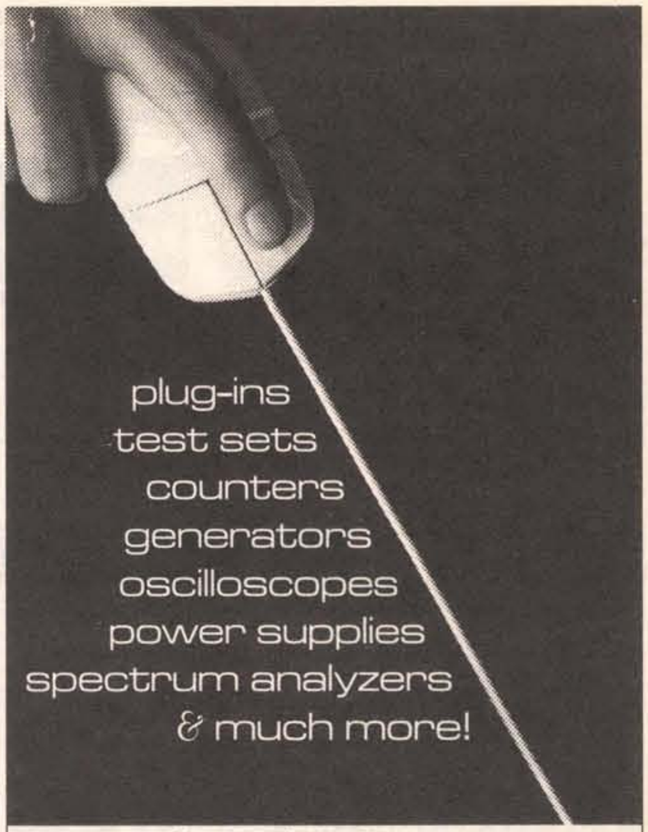

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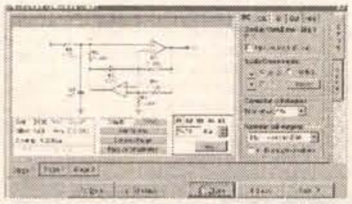

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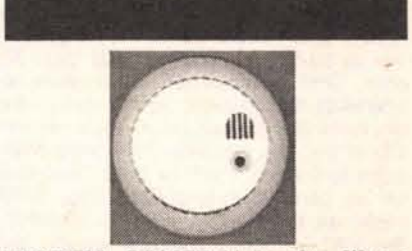

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Continued on page 57

Write in 43 on Reader Service Card.

by Steve Daniels

How To Draw Schematics Using MS Paint

One of the most common questions asked by beginning electronics hobbyists is: "How do I draw neat, accurate schematics? Drawing by hand seems awfully inefficient, but I don't want to spend a lot of money for special software."

Fortunately, there is a very good answer in the form of Microsoft Paint, the bitmap editor that is included in every copy of Windows. It's free, and you can use it to easily create a whole palette of your favorite symbols as shown in Figure 1.

I'll show you in this article how to use Paint to create the palette, and the basics of how to use it to do great schematics. If you've never used a bitmap editor, you'll start to learn how this sort of program works — a good thing for any 21st century professional or hobbyist to know.

I'm presuming that you're familiar with the basic point-and-click functions of Windows 95/98, and that you have some experience with dragging objects between windows and cutting and pasting. I won't presume that you already know Paint, so, if you do, please bear with my explanations of basic functions.

You can find the Paint application on the Windows Start menu under Programs/Accessories, but it is much more convenient to have a shortcut to it. If you don't already have a shortcut icon for Paint on your desktop, Figures 2 through 7 show how to put one there.

Creating Your First Symbol

We will be working with the Paint program opened in two windows: one for creating symbols and the other for storing them as a palette for later use. To begin, double-click the shortcut icon to start Paint. Reduce the application in size so that it is a window on the desktop. Now open a second instance of Paint and leave it maximized. The white background in this window should be 600 x 800 pixels in size, and Figure 8 shows how to set this up, if necessary. Symbols created in the

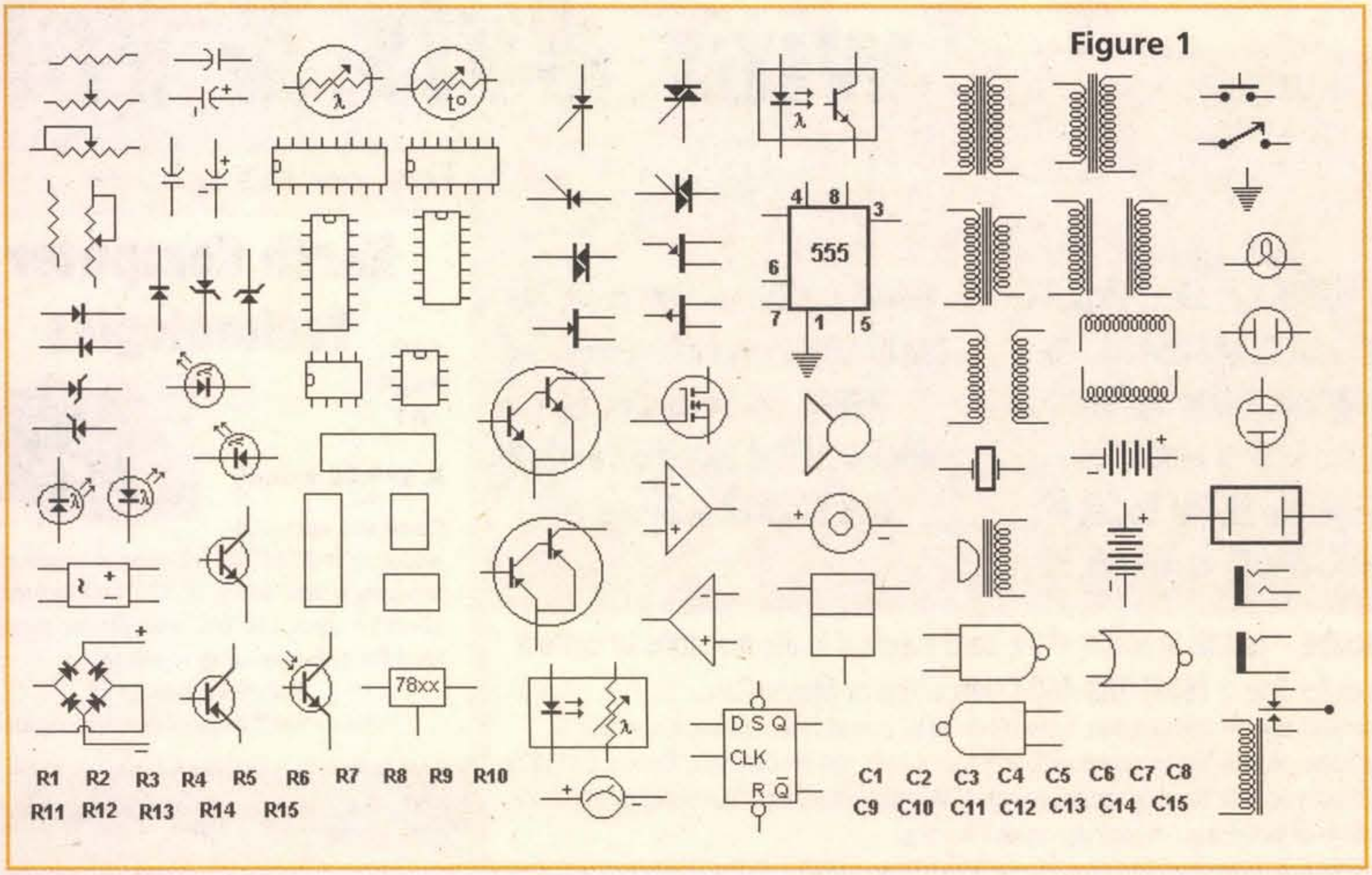

Figure 1

Figure 2

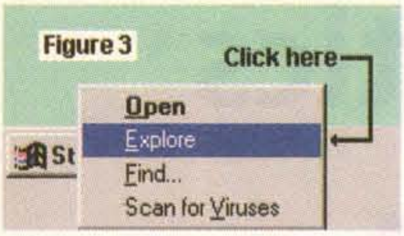

Figure 3

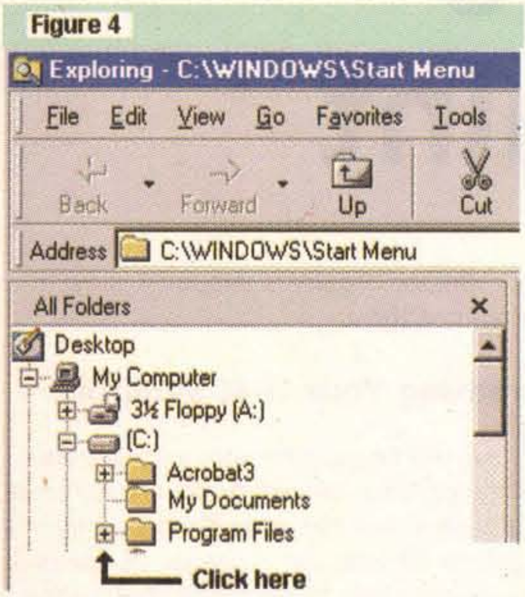

Figure 4

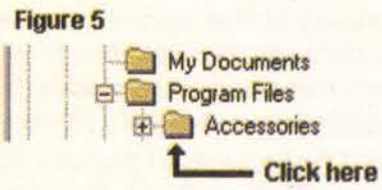

Figure 5

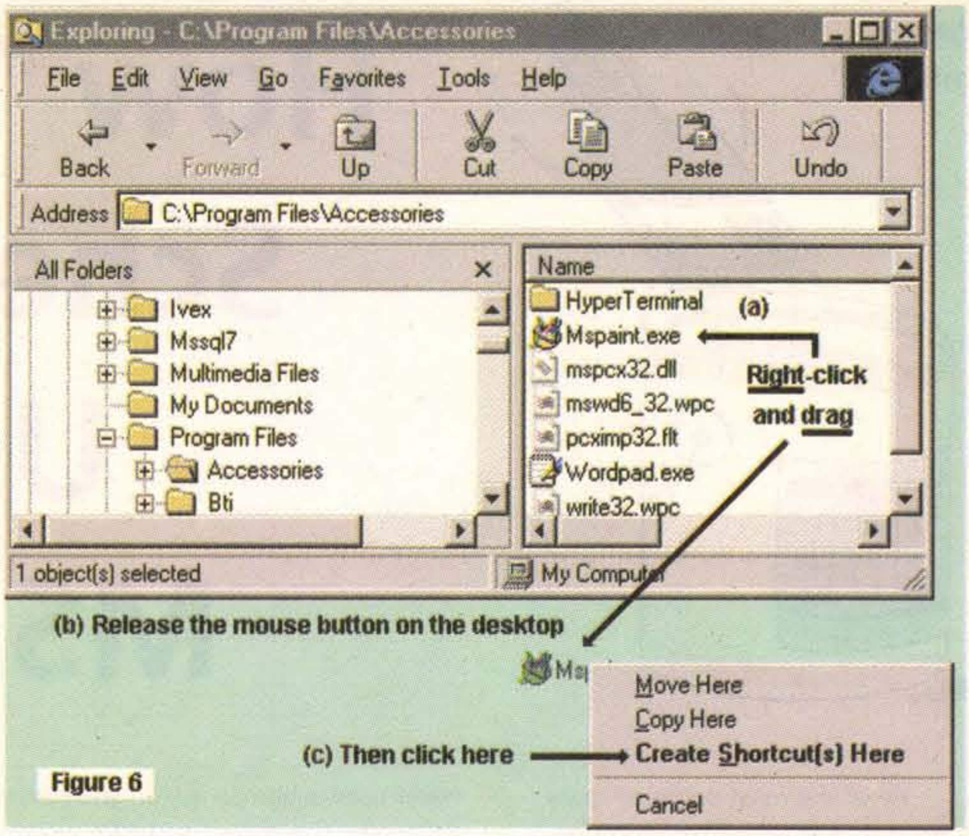

Figure 6

smaller window will be copied to this one.

In the menu of the large window, click Options, and make sure that Draw Opaque is NOT checked. If Draw Opaque is checked, click on it to uncheck it. See Figure 9.

Now go to the smaller window. While it is possible to "just draw" symbols if you have a

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NETCOM (page 11) will continue to provide prizes monthly!

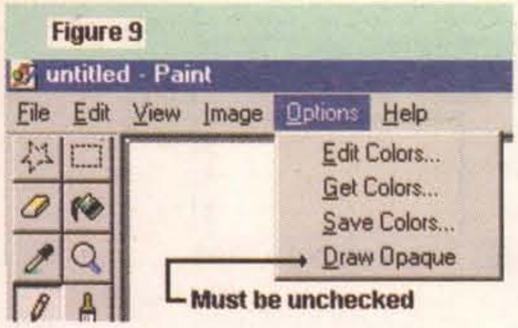


Figure 9

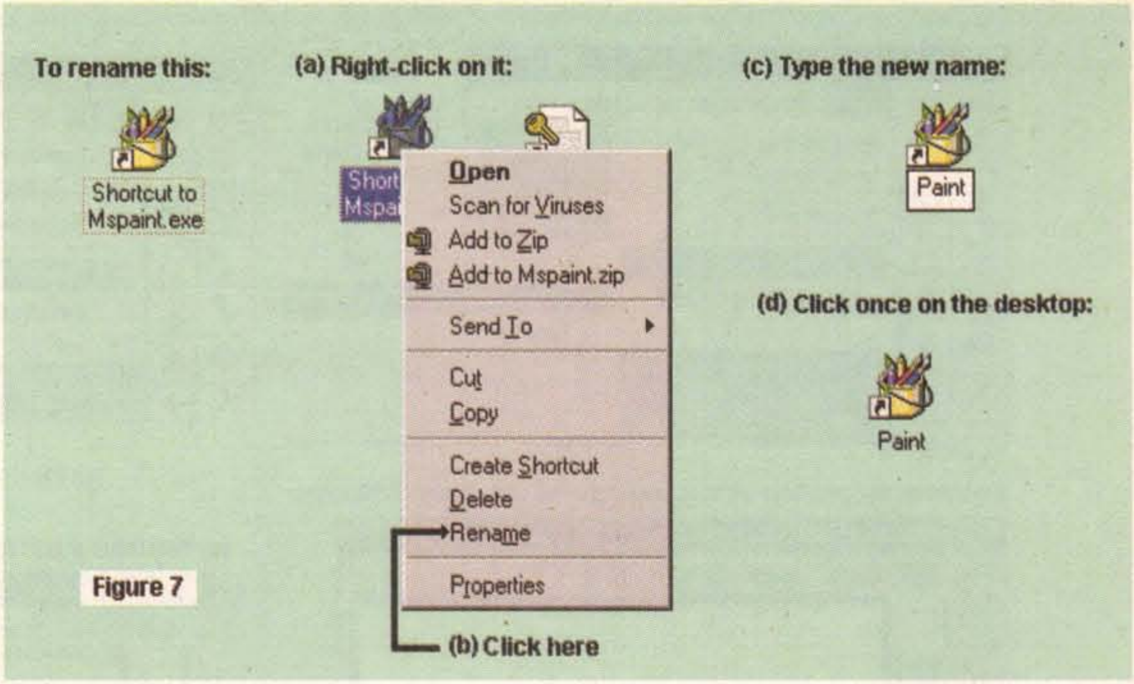


Figure 7

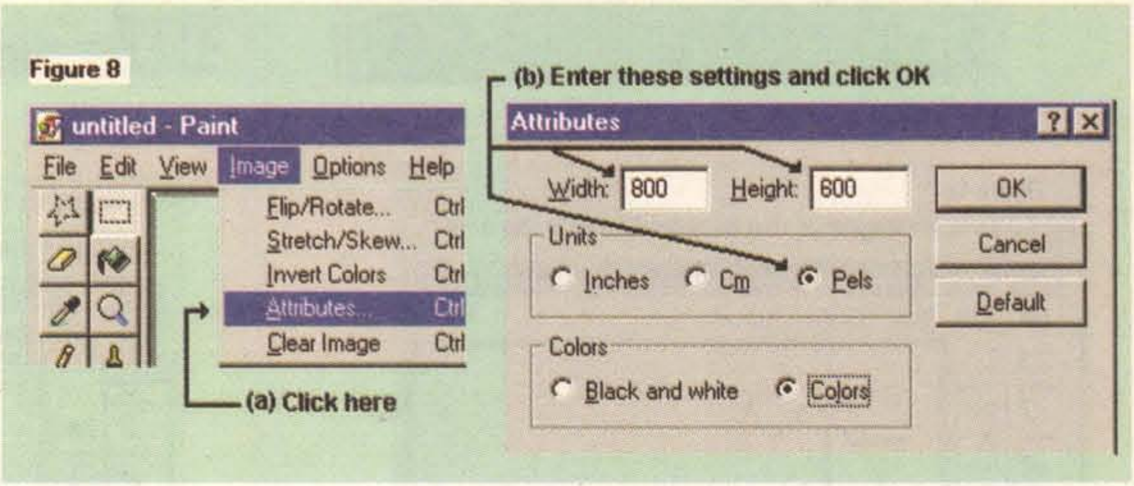


Figure 8

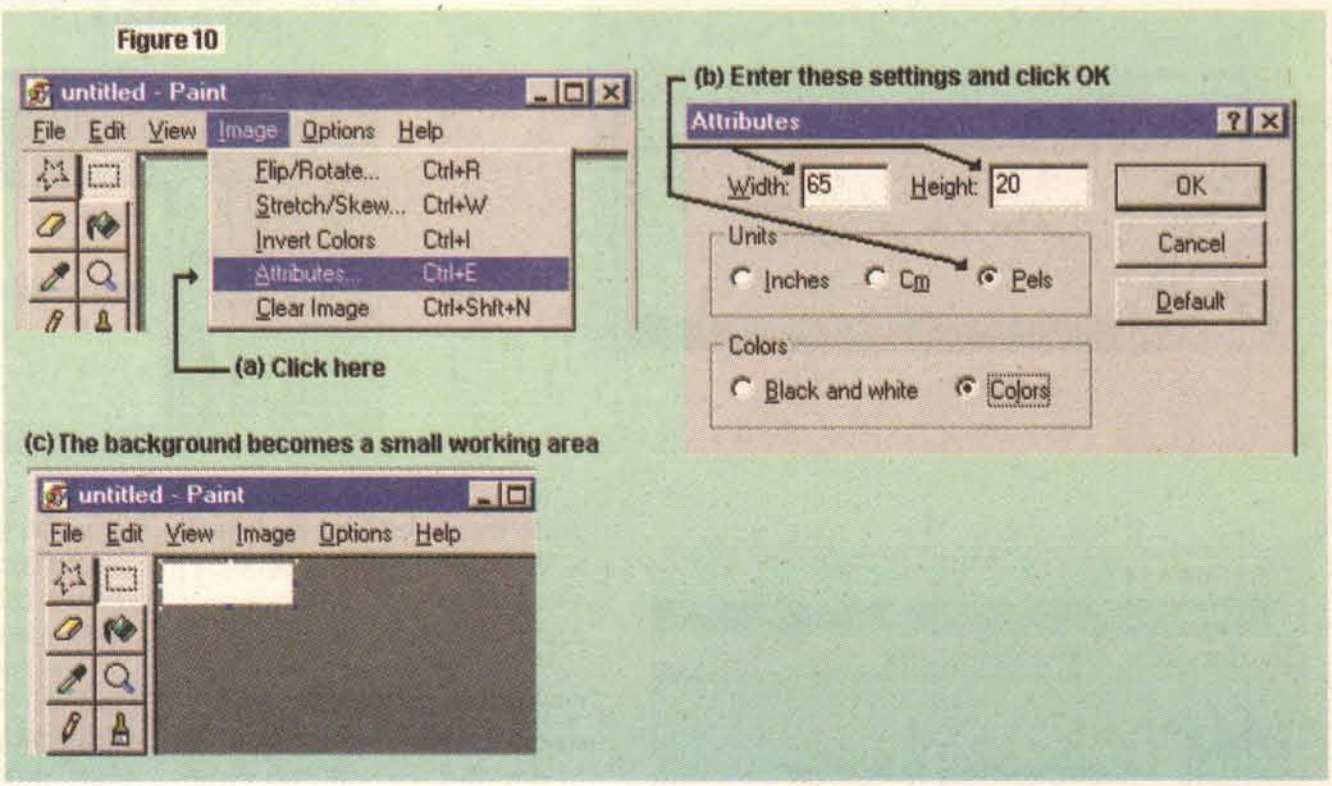


Figure 10

very steady hand and good eyesight, I found it convenient to create a small "composition" area — 65 by 20 pixels, in this case — and draw symbols dot-by-dot. Figure 10 shows how to create the area. Increase the zoom and change the view so that the background becomes a grid as in Figure 11.

Let's draw a resistor. As shown in Figure 12, click the pencil tool and use it to fill in dots by clicking in the squares of the grid — almost like following a paint-by-number drawing! I have shown the proportions that I used for the symbol I created, but you can make your own choices depending on the look-and-feel that you want for your drawings.

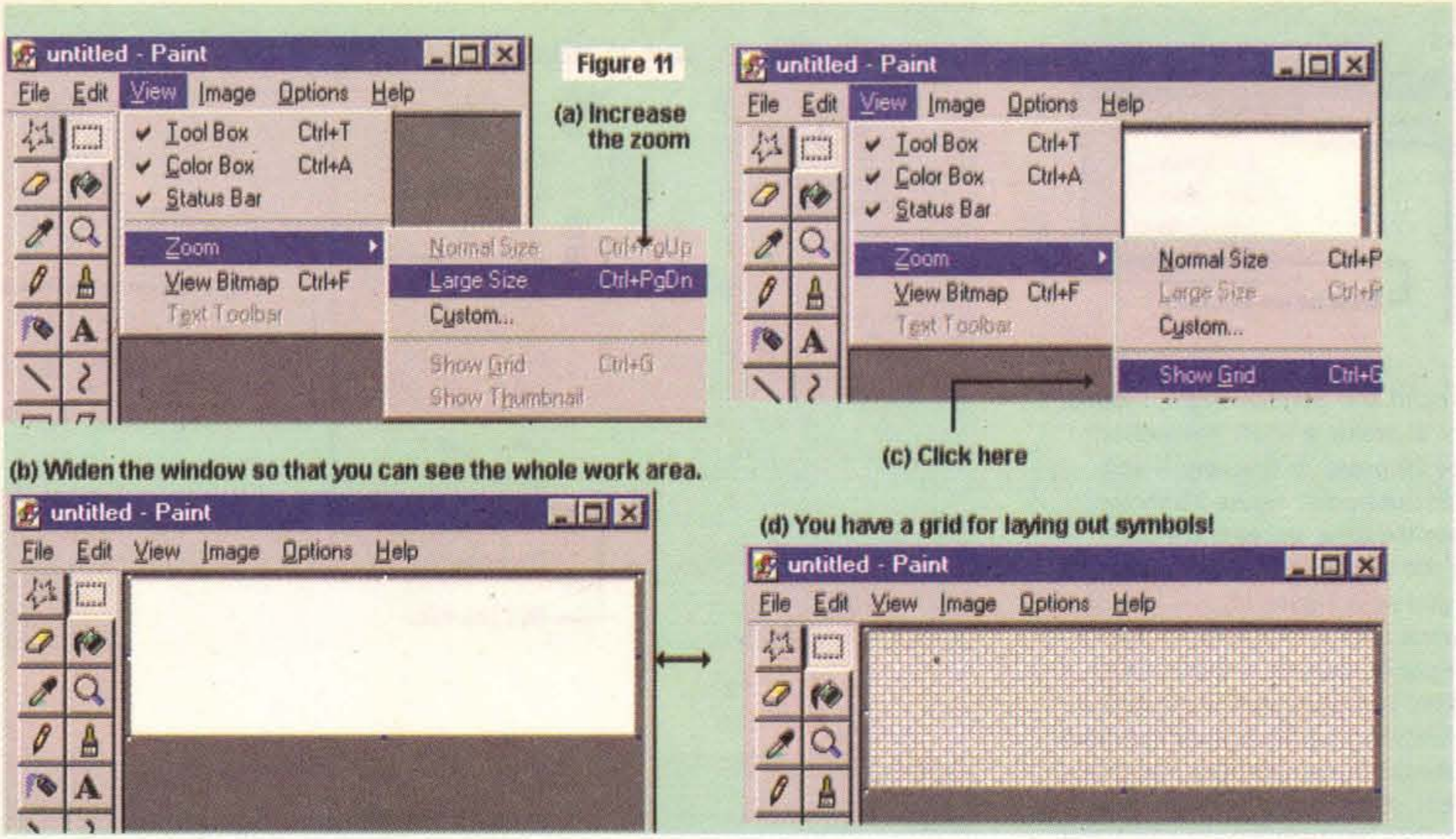
See Figure 13. Rubber-band the newly-created symbol and copy it to the clipboard (CTRL + C). Now go to the larger window and paste it on the palette (CTRL + V). Save the palette with the filename of your choice.

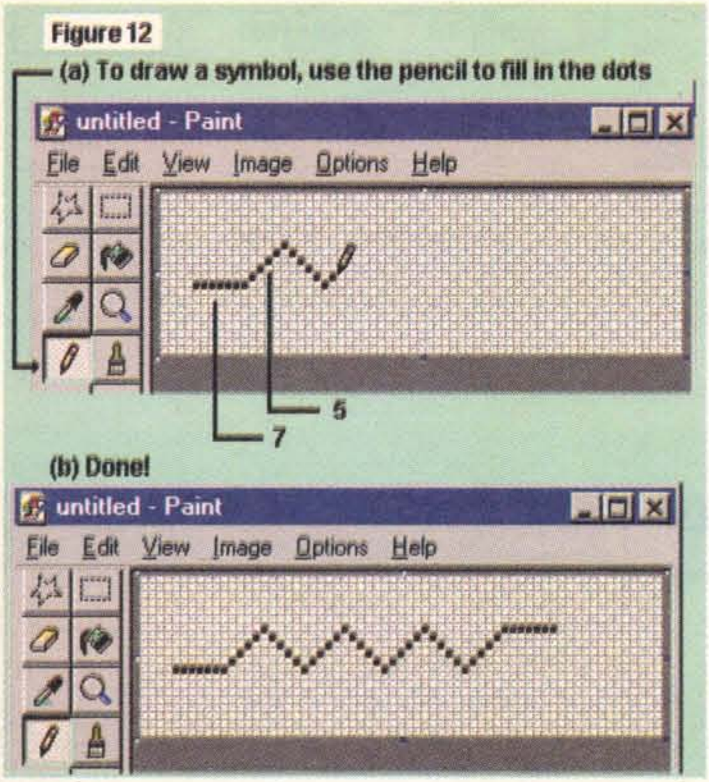
Return to the composition area. Unselect the resistor figure by clicking anywhere on the grid, and clear the grid by clicking Image/Clear Image on the Paint menu. Now draw a capacitor using the proportions shown in Figure 14. Copy this symbol to the palette and save the palette again. Figure 15 shows the proportions for a number of other common symbols, which you can also draw and copy to the palette. You will need a larger grid to draw the transistor and the op-amp, so, as you did earlier, set the size of the working area in the Attributes.

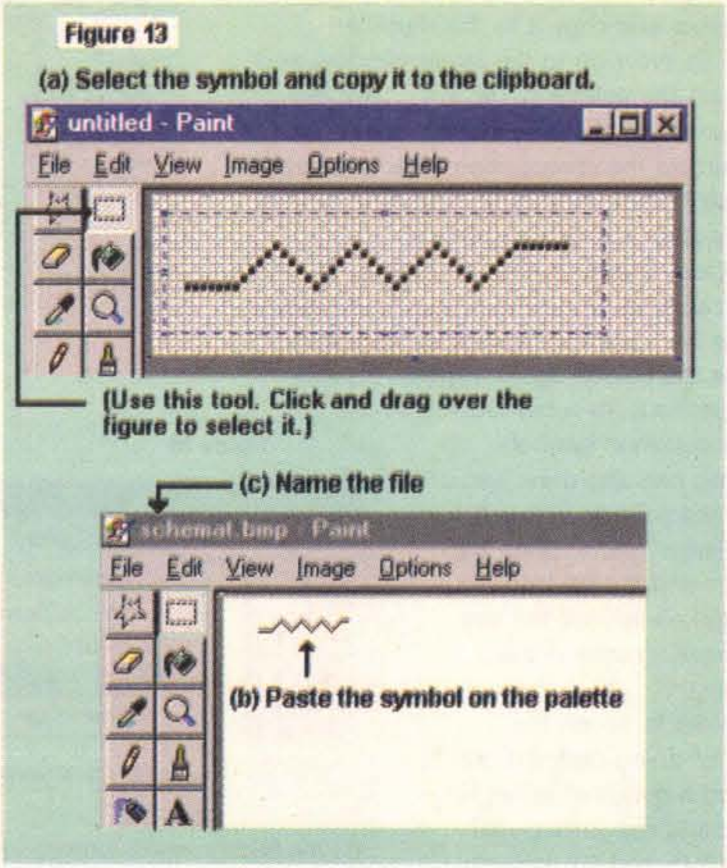
In order to speed the process of doing designations, I pre-typed a bunch of labels for resistors and capacitors — R1 through R15 and C1 through C15 — as you can see in Figure 1. When you have finished a drawing, it's very easy to just copy a whole group from the palette and slide the labels into place individually.

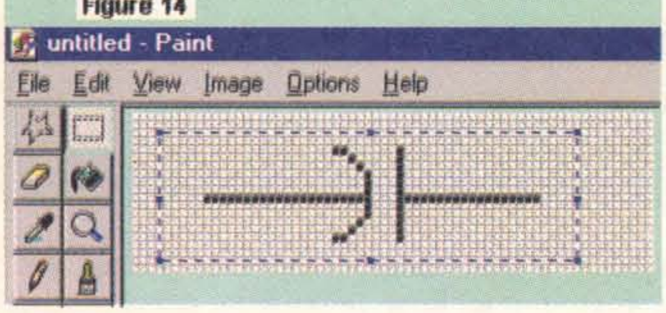
Drawing Schematics

Once you have a full palette of symbols saved, drawing a schematic is very easy. Open the palette in one instance of Paint. Open a second instance for your schematic, and see Figure 16 for the page setup parameters. These will give you as much use as possible of an 8-1/2 by 11 sheet in landscape orientation. Figure 17 shows the setup for Image/Attributes. Make sure that Draw Opaque is unchecked, and you are ready to go. Switch to the palette instance, rubber-band a symbol, and copy it to the clipboard, switch to the schematic instance, and









paste the symbol to the schematic. To connect symbols, either select a symbol and move it so that its connecting line merges with another symbol, or add lines as needed. Remember to save the schematic occasionally as you work. Paint permits copying, cutting, and pasting of any rectangular area, and you can use these functions to re-format the drawing as it grows and as your ideas change. Figure 18 shows a work in progress. For detailed instructions on how to use the tools on the Paint toolbar, consult the Help screens or a third-party reference.

It is entirely possible and desireable to construct "library" pages of commonly-used circuit patterns (power supplies, amplifier stages, logic blocks, etc.) and have these available whenever you need them. Like any software tool, the palette is only a starting point; feel free to bend it to your own needs and tastes.

Other bitmap editors can also be used for

Figure 15

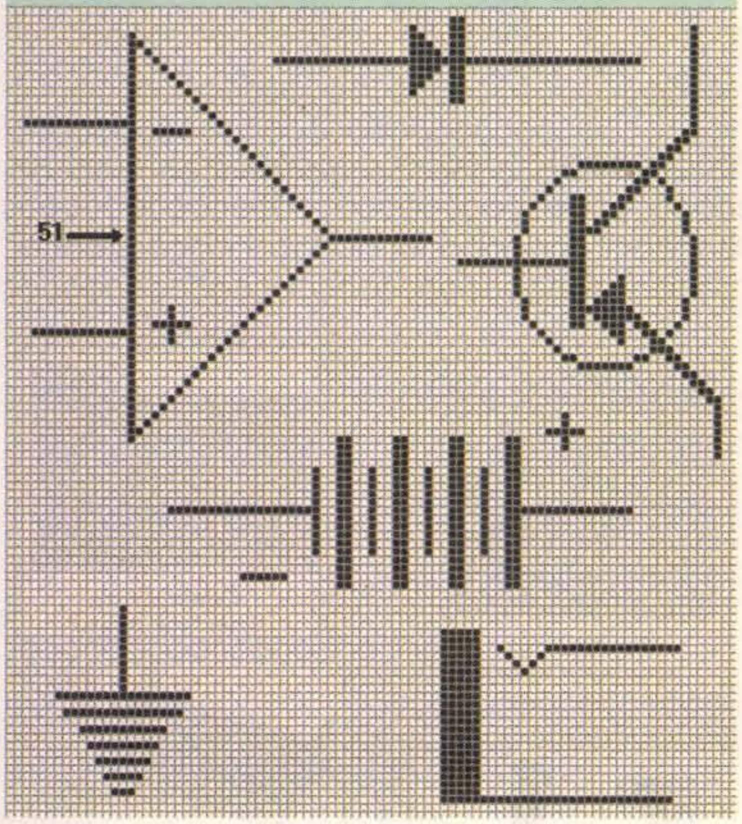


Figure 17

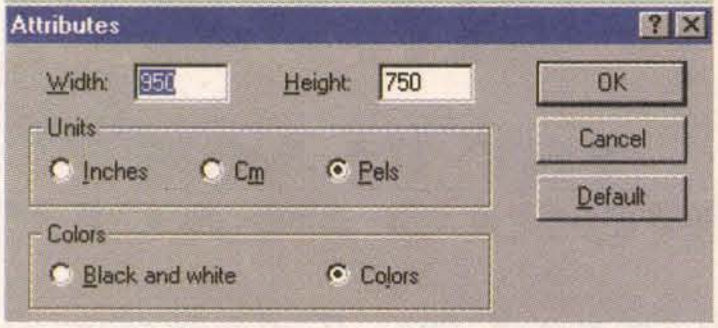
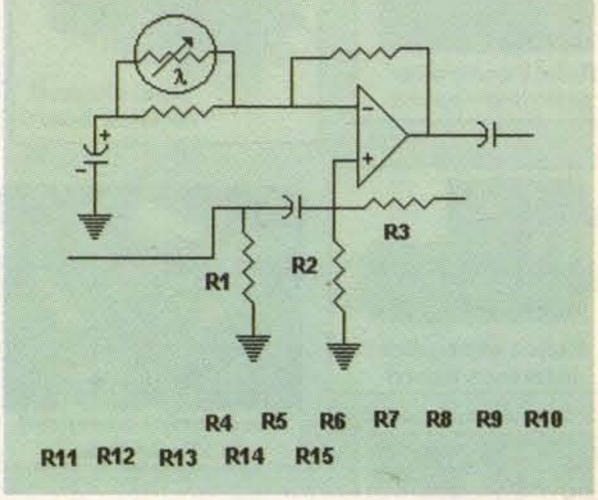


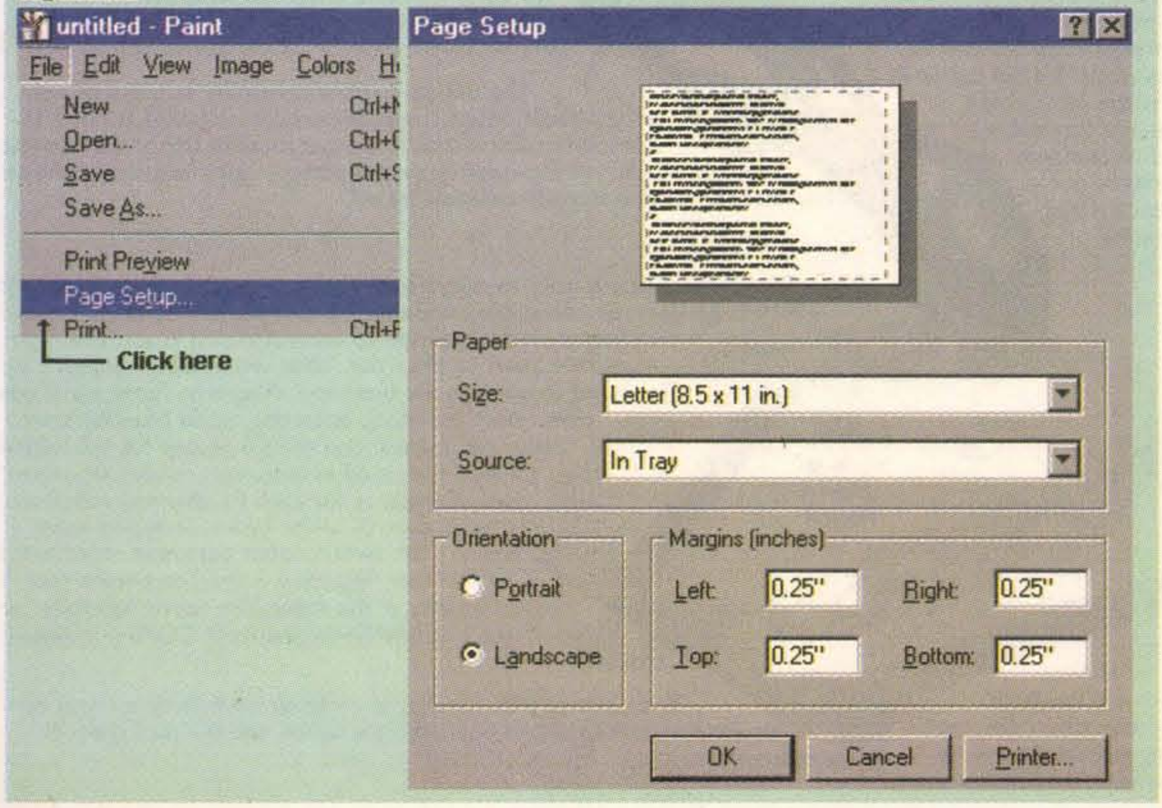
Figure 18



this application; in particular, I can recommend PaintShop Pro by Jasc software. That package does everything you would want of a bitmap editor, is much more flexible than Paint for those functions, and includes many functions for creating and editing graphics that are not available in Paint. PaintShop Pro does cost money, but you can try out a fully functional evaluation copy before buying it.

To anticipate a question: Yes, you could use the techniques described here to do PC board artwork by setting up a template and a palette of component outlines. However, while this method can be made to work for simple boards, I don't recommend pursuing it. My reason is that there are a number of inexpensive CAD packages available that are optimized for creating PC boards. They are all capable of creating a file format — called a Gerber photoplot — that is understood by fabricators and designers all over the world. A bitmap editor is not suitable when you want to have a factory make a board for you. My favorite package for doing board layouts is Ivex's WinBoard. You can download a no-charge evaluation copy — fully functional up to 100 pins — from www.ivex.com.

Figure 16



I hope you enjoy using the schematic symbols you've created, and I welcome comments and questions at smallbearelec@ix.netcom.com. If you would rather have the complete palette of symbols emailed to you, please send a check or money order for $10.00 to: Small Bear Electronics, 123 Seventh Avenue #156, Brooklyn, NY 11215. I can also accept MasterCard or Visa through PayPal, and you can find the PayPal icon on my home page: http://home.netcom.com/~smallbearelec. **NV**

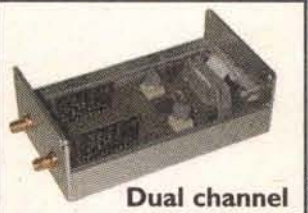
And the winner is . . .

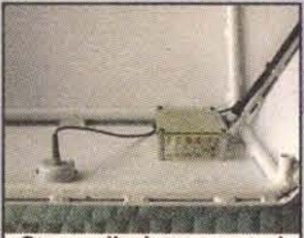
1ST PLACE "WORLD PEACE"

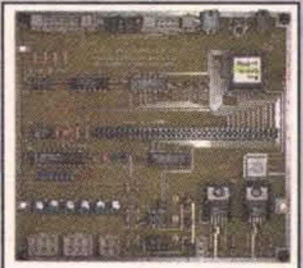
entered by Greg and David Campbell

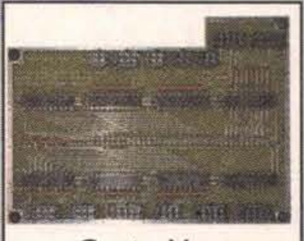
JUDGES COMMENTS: *"What impressed us most was the quality of the engineering. The circuit boards are designed very cleanly and the electrical and mechanical construction appears professional."*

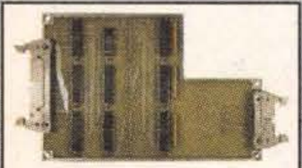

Robot controller processor board


Dual channel receiver board

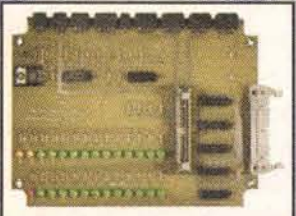

Status display mounted in World Peace

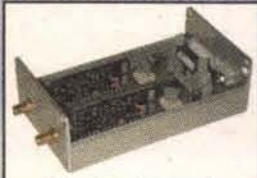

Control box processor board


Control box interface board

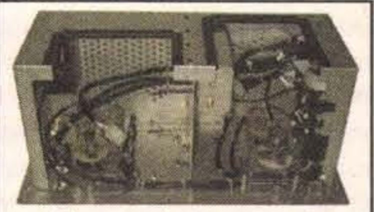

Robot controller interface board

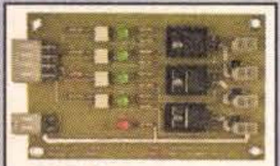

Electronics mounted in World Peace

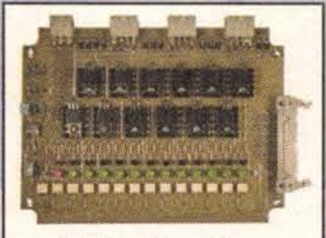

I/O Interface board

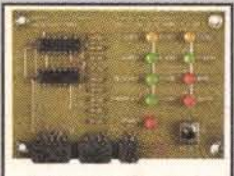

Dual channel transmitter board


External view of control box


Electronics mounted in control box


Self-Commencer interface board


Hydraulic valve control board


Status display board

The World Peace Project (Rev 02)

In 1998, my brother David Campbell and I formed Bohica Brothers Robotics and began building our first fighting robot, World Peace. With the help of the other members of Team Bohica (Ed Spencer, Ron Bitondo, and Ed Bitondo), World Peace made its first appearance in November 1999 in Las Vegas at the BattleBots Bot Bowl I (www.battlebots.com). We fought in the Super Heavyweight class and unfortunately were eliminated from the one-on-one in our first fight. We did better in our second fight in the rumble (all robots competing at the same time), which we won. So with our 1-1 lifetime record and lessons learned, we started work on World Peace (Rev 02). We had hoped to compete in the June 2000 competition in San Francisco, but we were not able to complete all of our upgrades in time. World Peace is anxiously waiting for its next chance to fight the good fight for truth, justice, and non-violent conflict resolution.

Onboard Robot Controller

World Peace is powered by a modified chainsaw engine driving a hydraulic pump (system pressure is 2000 psi). All robot functions (except for the electric start) are implemented with hydraulics. The onboard controller selects the best of the two 9600 baud RF links (900MHz modules were purchased to implement the RF link) to receive control signals to operate the robot. Basic controller functions include control of the chainsaw engine by adjusting the engine throttle setting based on hydraulic pump speed, and controlling the various hydraulic valves used to make World Peace go. The main weapons are the beak and lifting arm. Two hydraulic motors are used to drive the robot with separate left and right drive proportional valves for steering and speed control. Various safety interlocks are implemented to stop the robot if communication with the control box is lost, and to ensure the safe operation of the hydraulics.

The operating state of World Peace is displayed through nine LEDs. These indicate the active comm. channel, the relative signal strength of each comm. channel, good/bad messages received, throttle increase/decrease, and a power indicator. Status LEDs are also provided for each hydraulic valve and if the hydraulic system is enabled. The robot controller is based on the National Semiconductor COP8 microcontroller.


External view of World Peace

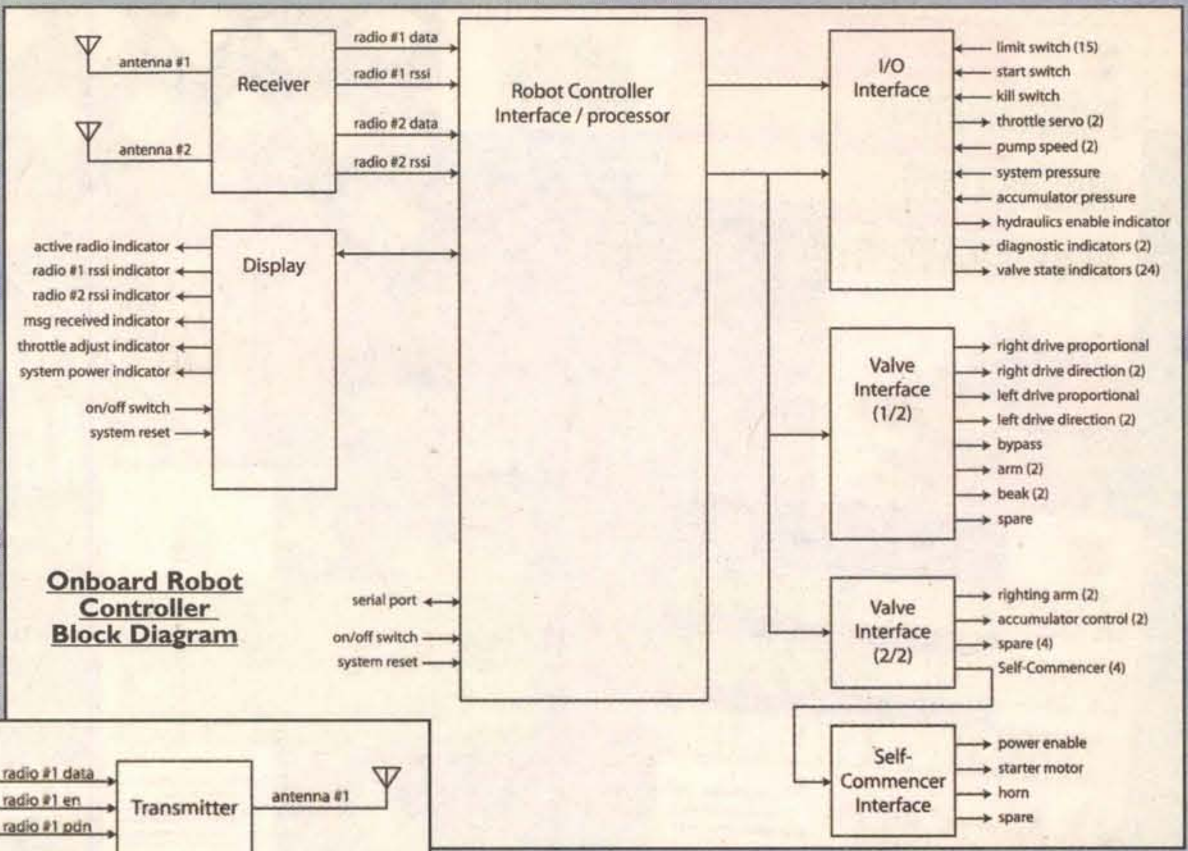
The onboard robot controller consists of eight circuit boards: robot controller processor board, robot controller interface board, dual channel receiver board, I/O interface board, hydraulic valve control board (2), status display board, and the self-commencer (engine starter) interface board.

Control Box

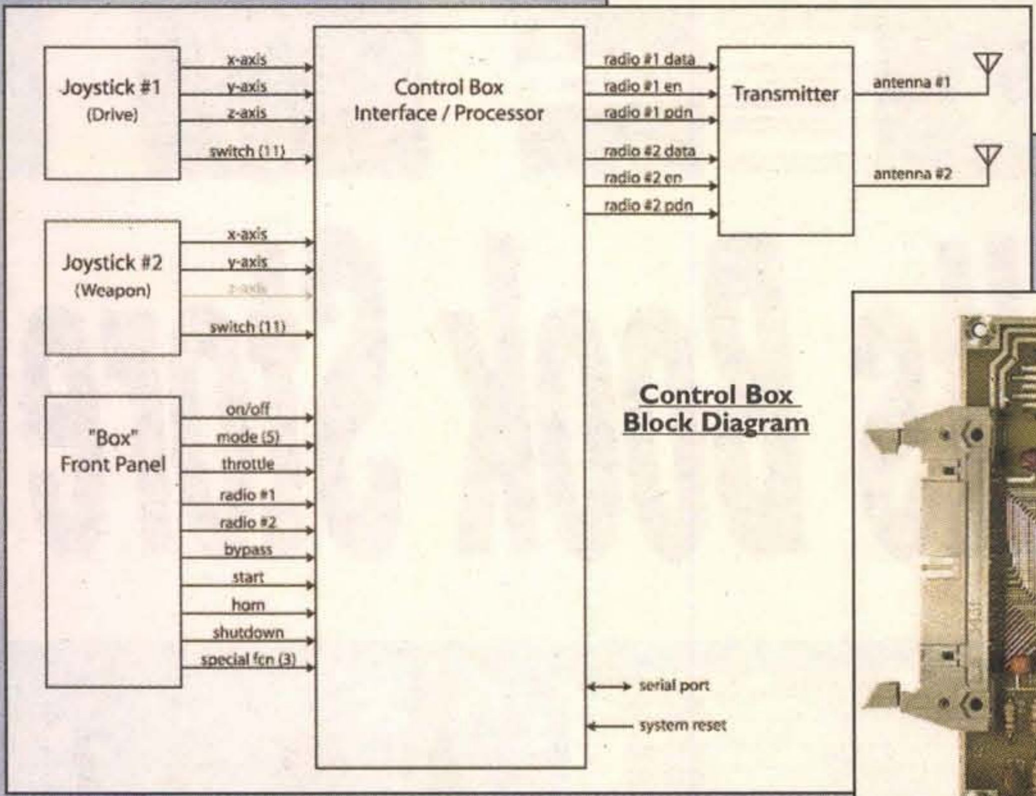
The Control Box is used to operate World Peace at a distance. Redundant 900MHz RF communication links transmit control packets 20 times a second. Two joysticks are used to control World Peace. The right joystick is used to drive the robot while the left joystick is used to operate the beak and lifting arm. Front panel controls select the robot operating mode (standby, start, automatic, manual, and test), manually set the engine throttle (not used in automatic mode), separate on/off switches for each RF channel, and allow manual control of the hydraulic bypass valve, engine start switch, robot horn, and shutdown. CRC16 error detection is used to ensure data packet integrity at the robot. The robot controller is based on the National Semiconductor COP8 microcontroller.

The Control Box consists of three circuit boards: control box processor board, control box interface board, and the dual channel receiver board.

Thank you to everyone who participated in the Nuts & Volts/ExpressPCB Electronics Design Contest. The competition was tough ... the judges had their work cut out for them!

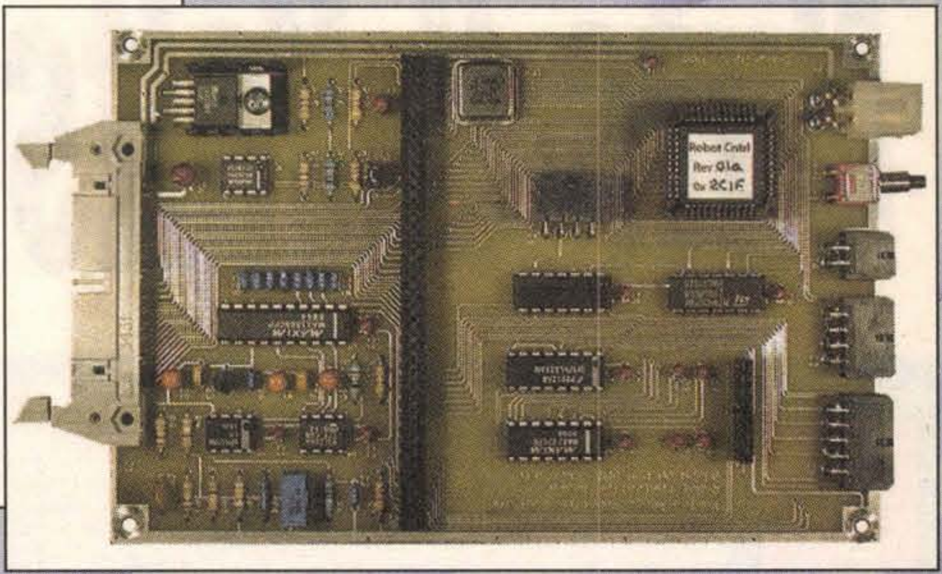


Onboard Robot Controller Block Diagram



Control Box Block Diagram

Be sure and check out next month's issue when the second and third place winners will be highlighted in more detail. Then, in November, our Honorable Mentions will be featured.

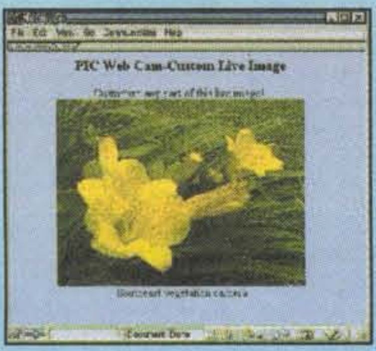


2ND PLACE

An Electronic Flight Computer entered by Jeff Karpinski

3RD PLACE

A PIC_ISA Control Board (sample application: a stand-alone web cam) entered by Dr. Edward Cheung



Honorable Mentions

"100 Watt Power Amplifier" entered by Robert E. Friess

"ClipClop" entered by David E. Smith

"WindReader"™ entered by Victor Fraenckel

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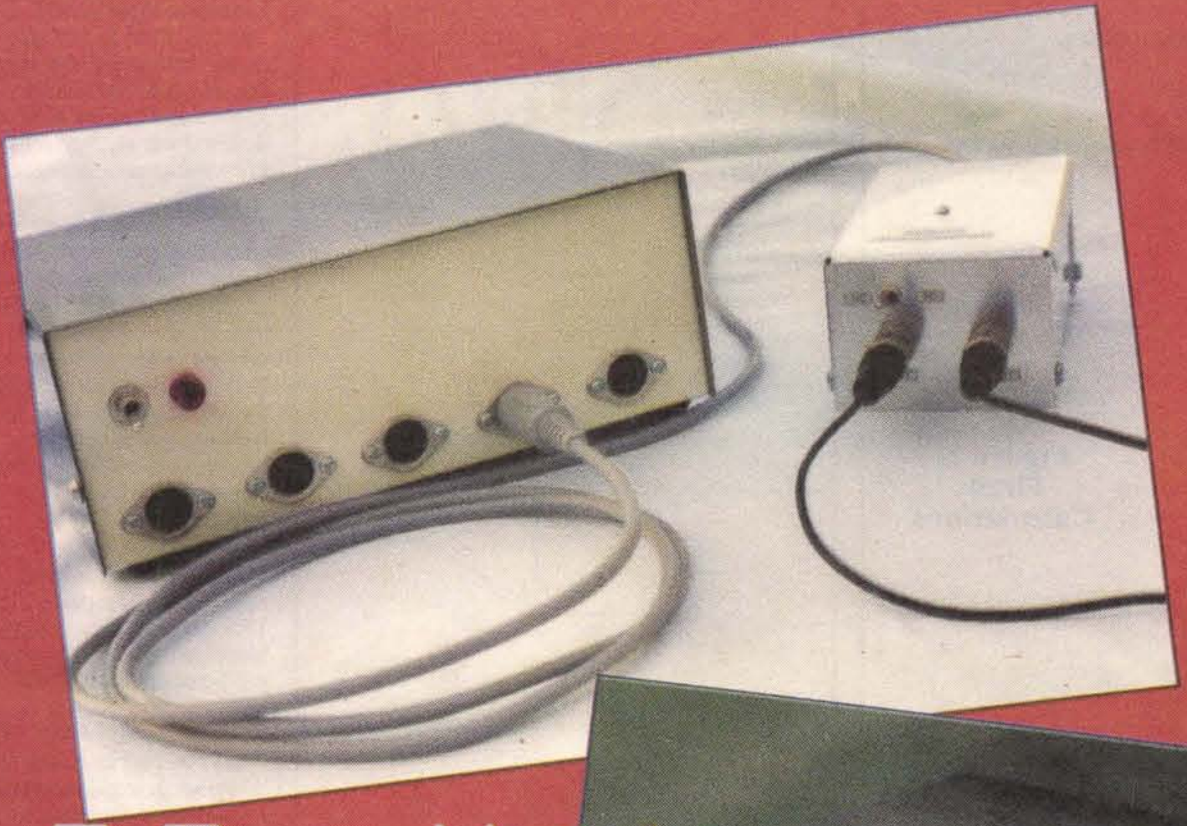
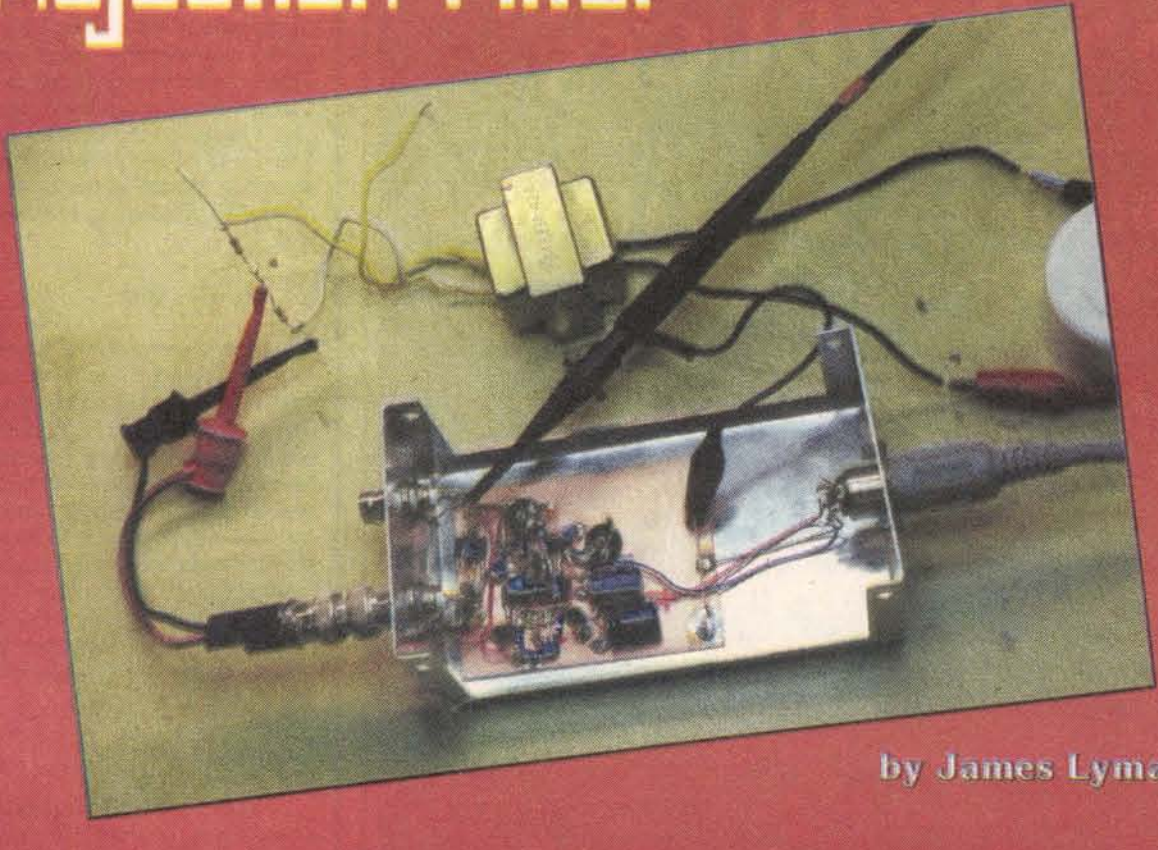
An Easy Hum Killer



A Deep Notch 60 Hz Rejection Filter



by James Lyman

In instrumentation, all of us have encountered one common problem, one that continually surrounds us in the world we live in — 60 Hz noise.

The penalty for all our modern conveniences is the AC power they use which surrounds us and continually radiates 60 Hz electromagnetic waves. These 60 Hz waves are usually strong enough to easily creep into low-level voltage signals we are trying to capture; showing up as noise that often is many times greater than the signals we are seeking.

When these signals are audio, we hear a constant low-frequency tone mixed with the audio we want to hear. This AC noise or hum can be disconcerting, and for something like music, is damaging in the sense of destroying the aesthetic qualities of the music.

Removing that AC noise without altering the signal requires a filter which rejects a small band of frequencies around 60 Hz without affecting other frequencies above or below the rejection band. This type of filter is called a band rejection filter.

This article describes a modular instrument which uses the common power supply described in the June 2000 issue of *Nuts & Volts* (pages 87-90, "Modular Instrument System").

A modular instrument is a simple instrument built in a stand-alone case, but having its power supply in another case which the instrument connects to using a five-pin DIN connecting cable such as RadioShack's part number 42-2151.

While this article describes the 60 Hz notch filter as a modular instrument, the basic filter circuit may be incorporated into other circuit designs requiring rejection of 60 Hz AC noise, such as audio applications.

If you have an audio recording with a 60 Hz hum, you can use this filter to drastically reduce that hum without compromising the audio itself, because this filter has a band width of only a few Hertz. This circuit is an active filter design that uses carefully-selected values of resistors and capacitors to determine the frequency of rejection.

Designing the Filter

Whenever I design an active filter, I go to the book that's the holy grail of designing active filters — *Rapid Practical Designs of Active Filters* by Johnson and Hilburn[1]. I bought this book while working on my EE degree, a time long ago that I won't confess to here, and have used it ever since with great success. I've used other books, good books I might add, as well as various computer programs. But I get the best results from using this book, an important consideration at an earlier time before we had computer simulators for electronic circuits.

As its name implies, this book gives the designer the tools to quickly design a wide range of active filters, up to an eighth order, by first selecting a basic capacitor and the cutoff frequency. The designer chooses the type of filter his circuit requires, such as a low pass forth order Chebyshev with 2 dB ripple, then goes to the appropriate table to calculate the component values.

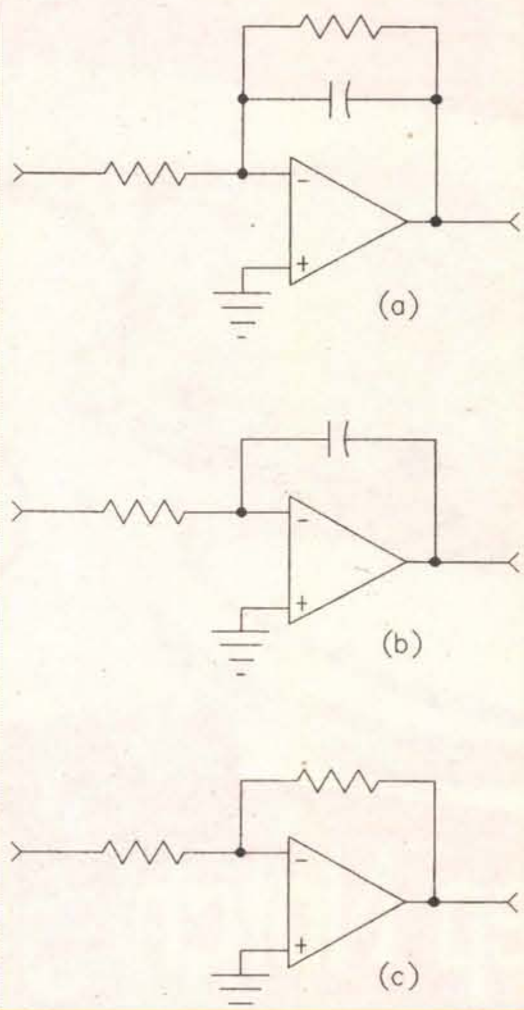
I have designed a number of different low pass, high pass, and band

$f_c := 60$	Center frequency in Hz, for rejection
$Q := 20$	Quality factor of filter
$C := 0.1$	Capacitor in uF, frequency tuning
$G := 1$	Filter gain, voltage ratio
$B := \frac{f_c}{Q}$	Relationship of bandwidth to quality factor
$B = 3$	Filter bandwidth in Hz
$K := \frac{100}{f_c \cdot C}$	Filter scaling factor
$K = 16.667$	
$R_1 := 1.592 \cdot K \cdot \frac{Q}{G}$	Resistor R1 in Kohms
$R_1 = 530.667$	
$R_2 := 1.592 \cdot Q \cdot K$	Resistor R2 in Kohms
$R_2 = 530.667$	
$R_3 := 1.592 \cdot K$	Resistor R3, R4, and R5 in Kohms
$R_3 = 26.533$	
$R_6 := 1.592 \cdot \frac{K}{G}$	Resistor R6 and R7 in Kohms
$R_6 = 26.533$	

Figure 1: Filter Calculations

"Rapid Practical Designs of Active Filters," David E. Johnson and John L. Hilburn, John Wiley & Sons, Inc., New York, NY, 1975.

Figure 2: Circuit Modules



pass filters using these tables, but band reject or notch filters are another matter — they tend to be a bit twitchy, especially if you want very narrow bands of rejection.

My first design was a Voltage Controlled Voltage Source (VCVS) band rejection filter using the book's design procedure (page 210). This involved selecting the desired center frequency, bandwidth, and capacitor values, then performing some simple calculations to give the resistor values. These calculations are given in the book and only involve substituting and doing the arithmetic which can be done with any calculator. But when the circuit was simulated with Electronic Workbench[2], I was surprised to find its center frequency way above the designed value and spent considerable time in determining resistor values to give a center frequency of 60 Hz.

The simulation never gave a narrow bandwidth design, but rather one with -3 dB points of about 35 and 75 Hz which would corrupt much of the data from a transducer. Although the VCVS design uses the fewest components for a second order filter, its predicted performance was unacceptable.

I then tried the Multiple-Feedback band reject design on page 213. This circuit is more complex than the VCVS requiring three additional resistors and a second opamp. Again, I simulated the design using Electronic Workbench and found its response so completely unacceptable, I didn't pursue it further.

I next tried the notch filter design in Don Lancaster's filter book[3] which uses a summing amplifier to take the outputs from an active low pass and high pass filter whose cutoff frequencies are selected to form a notch. Simulations of this design showed it having a wide bandwidth and a low level of rejection that is on par with the VCVS design but requiring considerably more parts.

Surprised that these designs were performing so poorly, I finally tried the Biquad band reject filter design, as outlined on page 215 and, despite the complexity of the circuit, I was surprised how well this circuit performed. This is definitely the circuit to use if you're serious about band rejection filters. I designed the filter for a gain of 1 and a Q of 20, where Q is the quality factor defined as the center frequency F_C, divided by the bandwidth BW.

$$Q = F_C / BW$$

Simulation showed its pass band to be extremely flat with an upper limit of 1 MHz. By adding two trimmer pots, the center frequency can be fine tuned to exactly the desired center frequency and the notch for maximum depth of rejection. Since the purpose of this filter is to reject 60 Hz power line noise, the fine-tuning ability allows you to make this circuit near ideal. The filter's performance is tolerant of component variations with no great changes in response from small changes in components.

The Design

To get good performance from active filters, you need to use close tolerance capacitors which are rather

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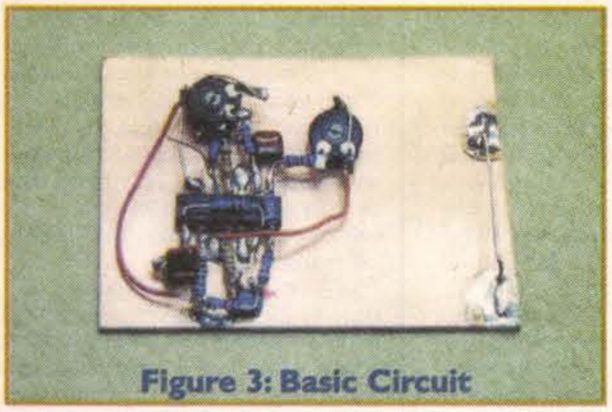


Figure 3: Basic Circuit

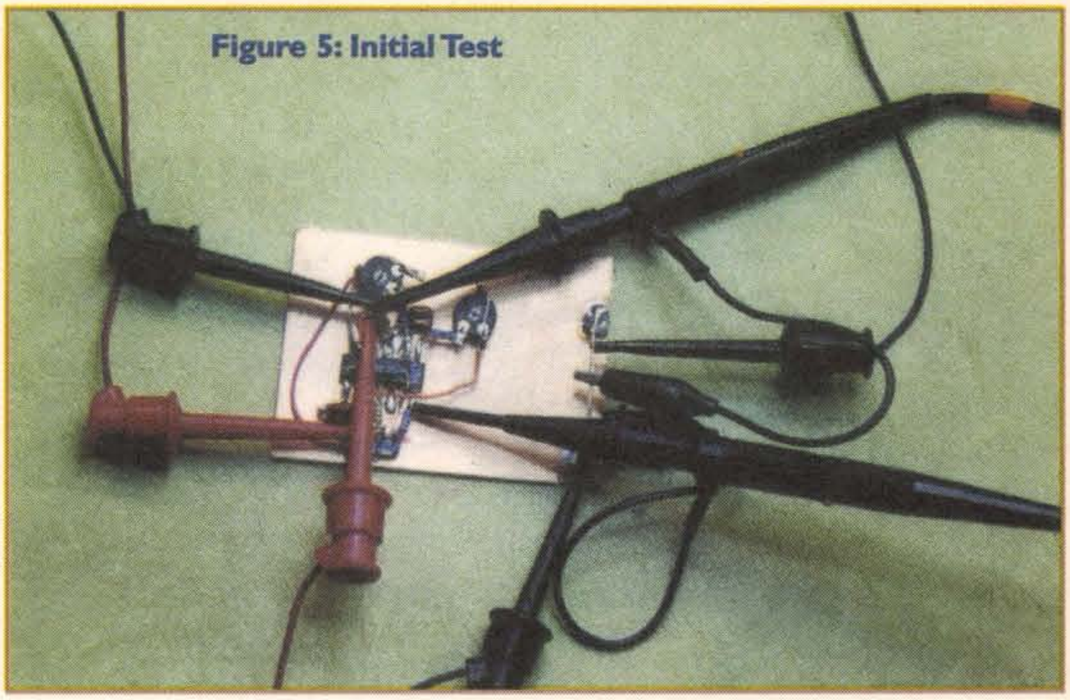


Figure 5: Initial Test

expensive and hard-to-find. Note — this does not apply to any of the power supply decoupling capacitors. The alternative to buying these is to measure capacitors and select the ones nearest the actual value. Anymore, capacitor meters are an inexpensive instrument often found in digital multimeters, so selecting capacitors is easy. Of course, the more capacitors you have, the easier it is to find accurate capacitors.

For me, the 0.1 uF capacitor is my most widely used value and therefore, I have a large number of them in inventory, so consequently I chose this value for my design.

The first step in the design is to calculate the scaling factor K which is used to scale the resistor values. This scaling factor is 100 divided by the product of the chosen capacitor value in microfarads times the center frequency in Hz.

The designer must choose two other parameters before calculating the resistor values — the over-all voltage gain of the filter and the bandwidth in terms of the quality factor Q. Since I wanted the maximum frequency response, which is limited primarily by the gain bandwidth product of opamps, I chose a gain of 1. A quality factor Q of 20 will give a bandwitdth of about 3 Hz, a value I considered having a minimum effect on signal quality together with the scaling factor; the frequency and the quality factor determine the resistor values by using simply addition, multiplication, and division with a calculator. The book gives a simple formula for each resistor. For those readers who use Mathcad[4], I have enclosed a Mathcad 6 file with the design calculations for a biquad notch filter that you can use in designing other notch filters with different parameters. The name of the file is bq60n20.mcd. A sample Mathcad printout of this design is shown in Figure 1.

I entered the filter design into Electronic Workbench using the exact calculated component values and the generic opamp model. The circuit was simulated using the bode plotter to test the frequency response which allowed me to quickly measure the -3 dB points, the center frequency, and its signal rejection in dB. The frequency difference of the -3 dB points gives the filter's bandwidth in Hertz. Next, I replaced the exact calculated resistor values with standard 1% resistor values and simulated the circuit again.

The filter's response changed little indicating the circuit is not very sensitive to component variations. Although the response was very good using standard values, I experimented and found those resistors which affected the center frequency and the depth of the rejection notch.

By replacing those resistors with the next lower standard values in series with a 1 Kohm trimmer potentiometer, I was able to exactly tune the simulated filter to 60 Hz with a very high rejection of about -50 dB. The Electronic Workbench circuit file is provided on *Nuts & Volts* web site for down loading by users who wish to further analyze this circuit. The file

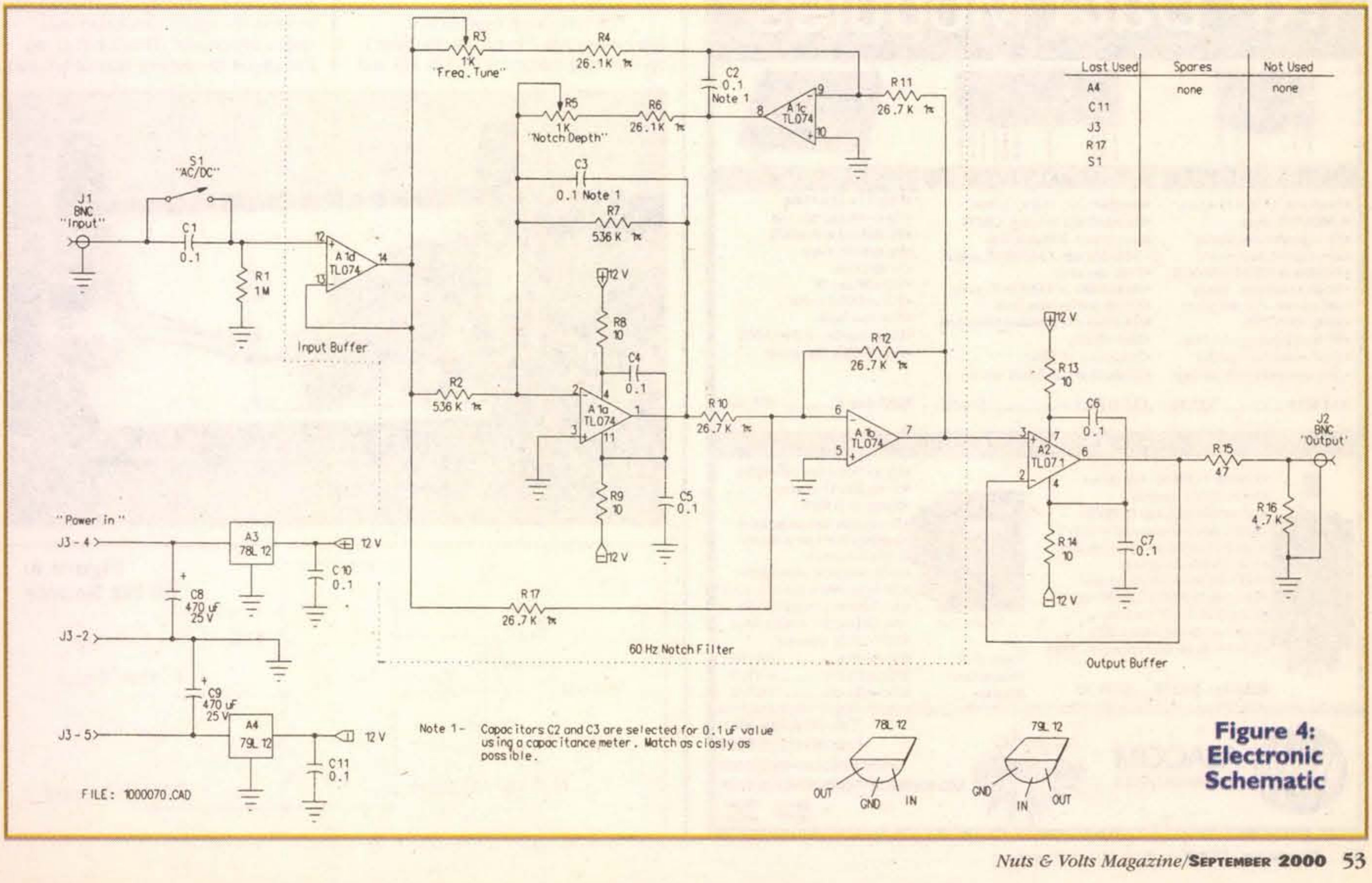


Figure 4: Electronic Schematic

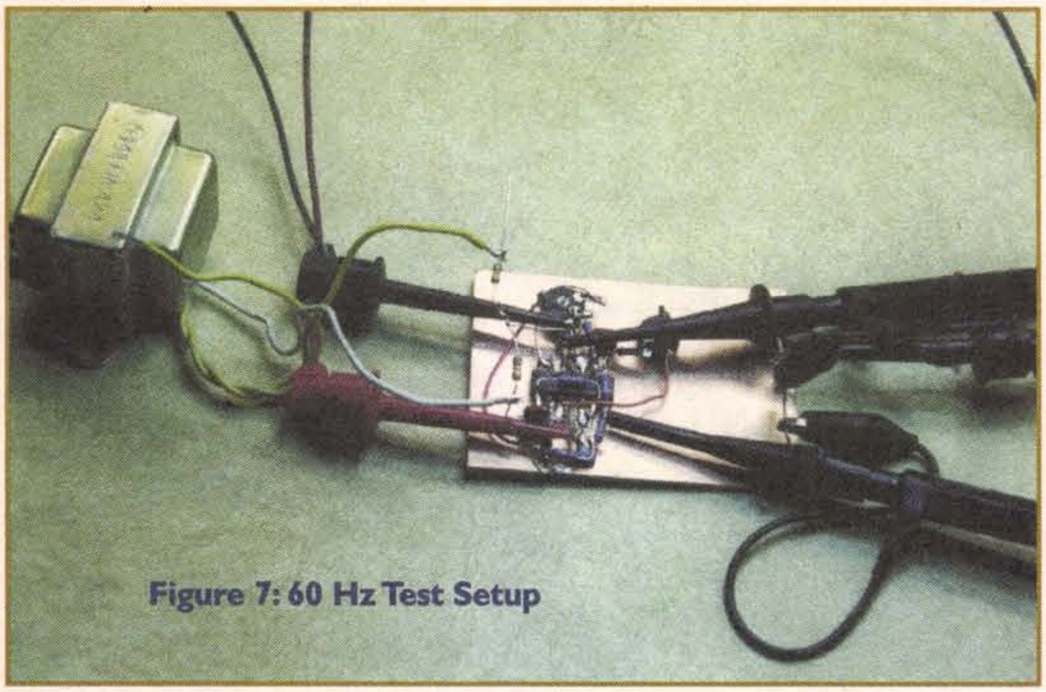


Figure 7: 60 Hz Test Setup

name is bq60n20.ewb.

The Circuit

The biquad circuit gets its name from its transfer function which has two quadratic functions in it. A transfer function is the algebraic expression which relates the input and output of a circuit. A circuit's transfer function can be calculated — if the experimenter is so inclined — by using the basic frequency expressions for capacitors and inductors combined with resistors. But since this involves one or more college courses to learn, we'll forgo discussing how it's done. The point is the transfer function for a biquad circuit has two quadratic functions, hence the "bi" for two and "quad" for quadratic, where quadratic means an equation in the form:

$$y = ax^2 + bx + c$$

However, unless you're a glutton for punishment, don't worry about it. That's why we have circuit simulator programs on our computers — so why all the discussion on transfer functions then? Well, the circuit of this filter is actually an analog computer[5] which is configured for the filter's transfer function.

For those who have known personal computers since their first memories, analog computers were once used when digital computers filled a large room, but had little more power than today's programmable calculators. Analog computers are composed of circuit modules which perform basic math functions such as addition, subtraction, multiplication, and even calculus functions such as derivatives and integration.

General-purpose analog computers were programmed by using patch cords to interconnect those modules and other components, while numbers were represented by voltage levels. Analog computers were used to model complex dynamic systems such as orbiting bodies and vibrating structures, such as an aircraft's wing.

As an analog computer, the biquad circuit uses three circuit modules that are shown in Figure 2, which, when connected together with a feedback path, gives the basic transfer function of one quadratic equation divided by a second one.

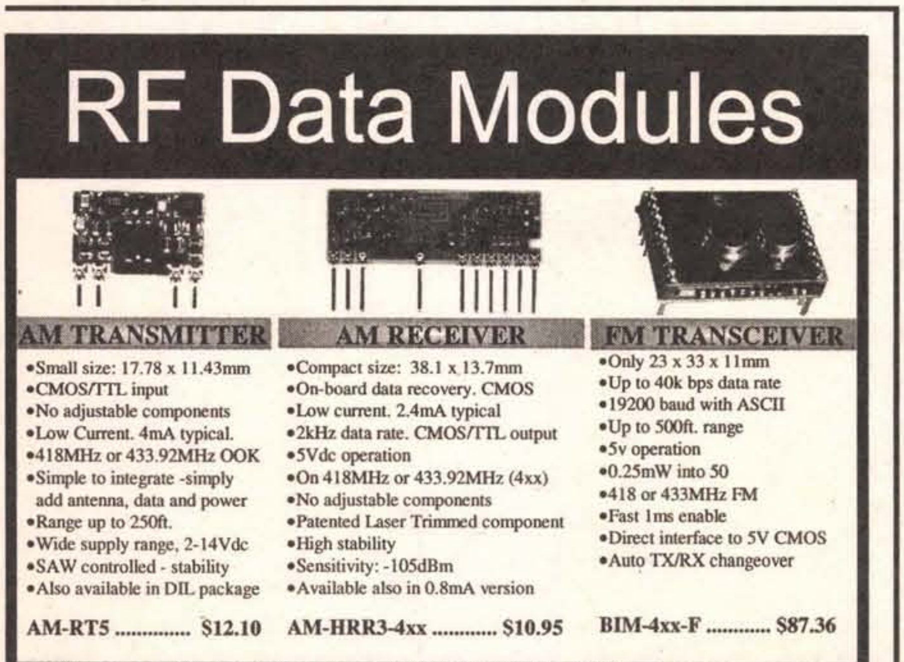
The first circuit module is the lossy integrator (Figure 2a), the next is an inverting integrator (Figure 2b) and finally the inverter of Figure 2c. By arranging these modules in slightly different order with feedback, the analog computer can represent the quadratic transfer function of a low pass, high pass, all pass, band pass, or band reject filter while selecting the values for resistors and capacitors will determine the filter's frequency response, in particular, the filter's cutoff frequency.

As expected, the input signal goes to the analog computer's input while its output provides the now filtered signal. As the input signal enters the analog computer, it is multiplied by the computer's transfer function and exits the computer's output having been modified; and since the transfer function is frequency dependent, different frequency components are modified by different amounts which results in the filtering action.

Calculating the required transfer function for a desired filter and then determining the values for the circuit components to give that transfer function is a somewhat tedious exercise in algebra, but *Rapid Practical Designs of Active Filters*[1] has already done the work for you so you only need to enter the filter's cutoff frequency and the value of the capacitor to quickly design a filter. But for those readers who wish to further explore this class of filters, M. E. Van Valkenburg's book *Analog Filter Design*[6] has a full chapter on the biquad circuit, chapter 5, titled "The Biquad Circuit."

Construction and Testing

I was very curious if I could actually achieve -50 dB rejection with the actual circuit, although I suspected not because the circuit simulation uses ideal components. This is not to say that circuit simulations cannot be used



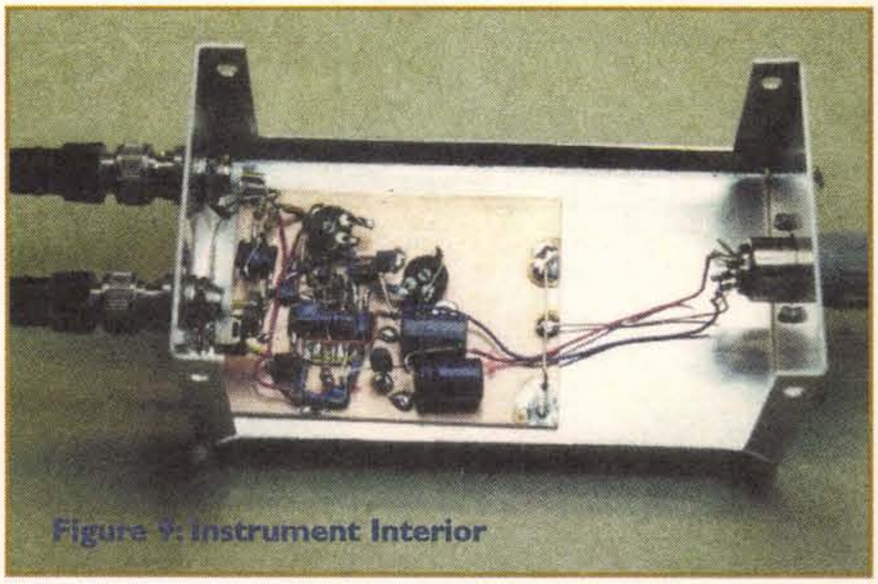
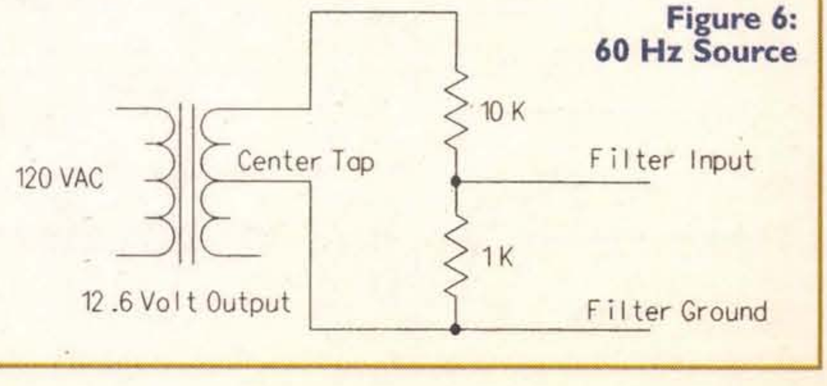


Figure 9: Instrument Interior

Figure 6: 60 Hz Source



or trusted, but rather they must be tempered by your experience in electronics.

Like any other tool, such as your oscilloscope or voltmeter, it has its limitations in accuracy. To test the filter's performance, I built the instrument in two stages — the first stage was the basic filter itself which could be tested in the lab, the second as the full instrument to be used with the modular power supply.

I built the basic filter circuit first to test the circuit's performance before putting the time, material, and effort into the full instrument — better to know it will work satisfactorily before fully investing in it. The circuit was constructed on a piece of blank circuit board which fits into an aluminum P-box enclosure sold in RadioShack stores. This is a 2 x 3 x 5 inch box, part number 270-238, selling for about $3.00, that makes an ideal case for modular instruments. My board measures about 2-1/4 x 3 inches and, as seen in Figure 3, the filter is built at one end.

Opamp A1 has all its leads bent outwards level with the chip so they don't touch the bare copper ground plane. Refer to Figure 4. Begin construction with the power supply decoupling network, R8, R9, C4, and C5, by cutting one lead of R8 to 1/4 inch and soldering it to pin 4 of A1. Now cut and form the leads of C4 to straddle the chip's body and solder it between pins 4 and 11 of A1.

Wrap one lead of C5 around a lead of R9 close to the resistor's body, then solder and cut the lead of R9 which has C5, to a length of 1/4 inch and solder that end to pin 11 to complete the network.

I placed the two high-frequency decoupling capacitors C10 and C11 on the free ends of R8 and R9 by looping a lead around the resistor's lead, soldering and trimming the capacitors leads flush. Trim the free ends of capacitors C10 and C11 to 1/4 inch length and then bend the resistor's leads up into a loop to allow connecting test leads for power.

With the network completed, you can position A1 on the circuit board and attach it by soldering the free ends of capacitors C10 and C11 to the circuit board. A1 has three opamps that connect to ground so use a small screwdriver to push pins 3, 5, and 10 down flush with the circuit board then solder each to the copper surface.

Now complete the basic filter circuit by installing those parts within the dotted box of the schematic diagram in Figure 4. Note that capacitors C2 and C3 are part of the frequency determining network of the filter, so their value is critical.

Precision capacitors are both expensive and hard to obtain, so use a capacitance meter to cull your stock of 0.1 uF capacitors and select the exact value. Although you want the value as near to 0.1 uF as you can get, the really important thing is for the capacitors to be matched, because the closer the capacitors are matched, the better the filter's performance.

Prior to testing, tack solder a short bare wire on pin 12 of A1 for attaching a test lead to inject the test signal; note that the input network S1, C1, and R1 are not needed for initial testing, as well as the output buffer amplifier A2. If there is insufficient room to clip an oscilloscope probe to pin 7 of A1, you may need to also tack solder a short length of bare wire onto pin 7 to form a test point.

Trimmer pots R3 and R5 are single turn printed circuit board mount trimmer resistors with their leads bent upwards. Use epoxy to glue a small bit of insulating material — such as part of a wooden toothpick — under each resistor to prevent accidental shorting to ground when adjusting. Be careful not to glue any moving parts on the bottom of the resistor since this will prevent their adjustment. Finally, use a length of #20 AWG bare buss wire, then form and solder a ground bar to the copper foil at the opposite end for attaching ground leads.

For testing, use a split power supply, setting its output to ±12 volts, with the positive rail going to R8, the negative to R9, and the ground lead to the ground bar. The circuit will pull less than 15 milliamps on either rail, so if greater than 15 milliamps disconnect, find the mistake before continuing.

Connect your function generator's output and one channel of your oscilloscope to pin 12 of A1 and adjust the level for about 1/2 volt pp sinewave at a frequency of about 200 Hz. Connect the other oscilloscope channel to the filter's output at pin 7 of A1 as in Figure 5.

If your filter is working correctly, the input and output levels will be the same amplitude. Now adjust the frequency to 60 Hz and the output amplitude should drop in level. Adjust resistors R3 and R5 for minimum amplitude, then sweep the frequency between 30 and 100 Hz. As you sweep across 60 Hz, the output amplitude will go very low while the input remains the same, but on either side of 60 Hz, the output will return to the same amplitude as the input.

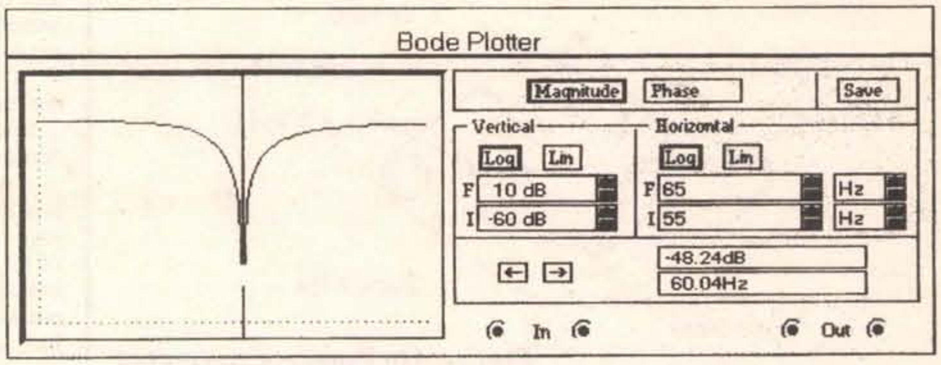


Figure 8: Electronics Workbench Filter Response

In doing this test, you will undoubtedly have trouble setting your function generator to precisely 60 Hz and, since this filter has a bandwidth of only a few Hertz, it's critical to have a precise 60 Hz signal. This is very easily done since your lab has a very precise 60 Hz frequency source available — the AC power in the wall socket that your instruments are plugged into. The AC power in your home is set very precisely to 60 Hz and since you are using this filter to remove 60 Hz noise from signals, it's exactly what you should use to set up your filter.

All that is required is a six-volt filament transformer and two resistors to form a voltage divider to give a 1/2 volt output signal. For six volts, a 1 Kohm and 10 Kohm resistor will give this signal, but if you have a 12-volt transformer use a 22 Kohm in place of the 10K. Remember, if you are using a center tapped transformer, use one side and the center tap. Refer to Figure 6 for the schematic and tack solder the resistors to the transformer's leads, then check its output with the oscilloscope. This output signal can be connected to the filter by either using test leads, by soldering short lengths of wire for jumpers, or by tack soldering the transformer's leads directly to the filter as in Figure 7. Again, while monitoring the filter's output, adjust R3 and R5 to give a null, that is, a minimum output signal. My filter gave a rejection of about -25 dBV which is calculated by:

$$\text{Rejection, dBV} = 20 * \log_{10}(\text{Vout} / \text{Vin})$$

Vin and Vout can be RMS, peak volts, or peak-to-peak volts — the only restriction is they must be the same units. If you're using a DVM for measuring, its AC scale should be true RMS since the output waveform at center frequency is complex instead of a sinewave. The -25 dB rejection is about half the rejection obtained by analysis using Electronics Workbench, but if you move the bode plot cursor in Electronics Workbench just a fraction of a Hertz from the center frequency, the rejection quickly approaches the real filter's performance. Refer to Figure 8.

The notch at the center frequency becomes extremely sharp which does not occur in the real world. When the span of the bode plot is set from 59 to 61 Hz, a change of 0.01 Hz from center frequency gives a change in notch depth of 10 dB. Furthermore,

Ref. Desg.	Qty.	Nomenclature	Part Number
A1	: 1	: TL074 Quad Bi-FET Op-Amp, 14 pin DIP	: note 1
A2	: 1	: TL072 Dual Bi-FET Op-Amp, 8 pin DIP	: note 2
A3	: 1	: 78L12 +12V, 100 mA, 3 Terminal Voltage Regulator, TO92	: note 3
A4	: 1	: 79L12 -12V, 100 mA, 3 Terminal Voltage Regulator, TO92	: note 4
C1-7,10,11	: 9	: 0.1 uF Monolithic Bypass Capacitor, 25V	:
C8,9	: 2	: 470 uF Electrolytic Capacitor, 25V	:
J1,2	: 2	: BNC Panel Mount Bulkhead Recept, Solderable	: note 5
J3	: 1	: 5 position DIN Receptacle, Panel Mount	: note 6
R1	: 1	: 1 Mohm Resistor, 5%, 1/4 Watt	:
R2,7	: 2	: 536 Kohm Resistor, 1%, 1/4 Watt	:
R3,5	: 2	: 1 Kohm Potentiameter Resistor, Single Turn	:
R4,6	: 2	: 26.1 Kohm, 1%, 1/4 Watt	:
R8,9,13,14	: 4	: 10 ohm Resistor, 5%, 1/4 Watt	:
R10-12,17	: 4	: 26.7 Kohm Resistor, 1%, 1/4 Watt	:
R15	: 1	: 47 ohm Resistor, 5%, 1/4 Watt	:
R16	: 1	: 4.7 Kohm Resistor, 5%, 1/4 Watt	:
S1	: 1	: SPST Micro Miniature Toggle Switch, Panel Mount	: note 7
	: 1	: Aluminum P-box, 2 x 3 x 5 inches	: note 8

note 1 - Digi-Key part number 296-1777-5-ND
note 2 - Digi-Key part number 296-1775-5-ND
note 3 - Digi-Key part number NJM78L12A-ND
note 4 - Digi-Key part number NJM79L12A-ND
note 5 - Digi-Key part number ARFX1064-ND
note 6 - Digi-Key part number 275-1014-ND
note 7 - RadioShack part number 275-624
note 8 - RadioShack part number 270-238

PARTS LIST

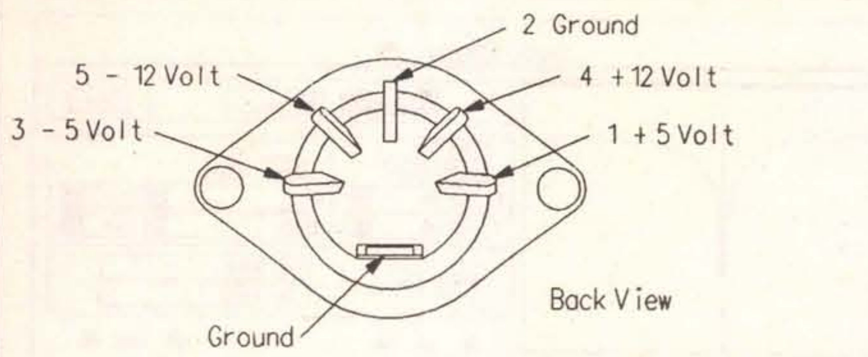


Figure 10: Power Connector

the depth of the notch varies with the settings of the bode's start and stop frequency, another indication that we are looking at a mathematical artifact instead of real-world performance.

If testing shows the basic filter to be working correctly, continue building the instrument by installing the output buffer amplifier A2 and the input network C1 and R1. Again, start by installing the power decoupling network R13, R14, C6, and C7 to opamp A2, then position the assembly on the circuit board and solder the free end of C7 to the circuit board. Install the DC return network R15 and R16 then connect pin 7 of A1 to pin 3 of A2. You may want to do another test before finishing the power supply because, if there is a problem, you have more room to work without the clutter of the power circuits.

Install the filter's power circuits which consists of regulators A3 and A4 and capacitors C10 and C11. Start by spreading the input and output leads of A3 and A4, then bend the end (1/4 inch) of each ground lead 90 degrees and finally, solder the regulators to the circuit board via their ground leads.

Note that the schematic (Figure 4) has the pinouts for A3 and A4. Position the output of the regulators leads as near to the power input pins of A1 as possible. Complete the power supply by installing the two filter capacitors and then connect the regulator outputs to the circuit power using the regulator's output leads directly or insulated wire if the distance is too great.

You may want to test the circuit before installing the board in its case by using a laboratory power supply. If so, be sure and set the power supply voltage at least three volts above the regulator's 12 volt output to ensure the regulators will correctly regulate.

Case

When you are satisfied that your notch filter is working correctly, you can install it in the case, but I advise you to do all the sheet metal work first. This involves drilling holes for the three panel jacks and a toggle switch. The ends of the case's top are used as the instrument's front and rear panels. The input and output jacks J1 and J2 are panel mount BNC connectors which mount in 3/8 inch holes drilled in the front panel.

The "AC/DC" select switch S1 is mounted just above the input connector J1. The power connector J3 is mounted on the opposite end of the case's top in approximately the center. This connector is a five-pin DIN panel mount connector that requires a 5/8 inch hole that is too large to drill cleanly in such thin sheet metal, even if you have a drill bit that large.

This hole must be drilled smaller and expanded with a rat tail file until J3 will pass through the hole. If you are going to be doing very many of these, I strongly recommend investing in a chassis punch such as a 5/8 inch Greenlee round metal punch set, part number 500-2409.4. This punch allows you to drill a small hole, mount the two halves of the punch on either side with a bolt passing through the hole to connect the punch halves together, then by tightening the bolt with a wrench, you cut a perfect 5/8 inch hole in the sheet metal. Much easier than fighting with a file and trying to get the connector to fit.

You can mount J3 using screws and nuts, but I find it easier to use 1/8 inch aluminum pop rivets which don't work loose.

As seen in Figure 9, the circuit board is mounted on the inside of the case top with the filter input (pin 12 of A1) close to the front panel which has J1 and J2. While holding the circuit board in position, drill a 1/8 inch hole at the center of the circuit board, through both the circuit board and sheet metal top cover, then use a 4-40 x 1/4 screw and nut to secure the circuit board in place.

With the circuit board secured, cut one end of the input resistor R1 to 1/4 inch, then bend the other lead 90 degrees about 1/4 inch from the resistor's body. Solder the straight part of R1's long lead to pin 12 of A1 with the bent part of the lead pointing upwards. The resistor's body should be in line with pin 12 and laying against the circuit board.

Now press the short lead of R1 against the circuit board and solder it to ground. Finally, the lead of R1, which is pointing upwards (pin 12 of A1), is connected to one side of the switch S1 ("AC/DC") and soldered. Connect a wire from the other side of switch S1 to the center terminal of J1 ("Input") and solder both ends.

The bypass capacitor C1 is connected across switch S1 by soldering its leads to the leads already connected to switch S1. For the filter's output, solder a wire from the junction of R15 and R16 to the center terminal of J2 ("Output").

Finally, connect the +12 volts of J3 (terminal 4) to the input lead of regulator A3 and the -12 volts of J3 (terminal 5) to the input lead of regulator A4 using insulating wires. Connect the grounds of J3 (terminal 2 and Ground) to the copper foil of the circuit board using either insulated or bare buss wire. Refer to Figure 10 for terminal locations. Your instrument is now ready for use.

Make a final test and adjustment of the filter by connecting the input of the notch filter to the signal source shown in Figure 6, 60 Hz Source, and the filter's output to an oscilloscope or voltmeter. Again, adjust R3 and R5 for minimum signal level which gives you the highest rejection of 60 Hz noise.

If you need higher rejection, you can cascade additional notch filters together with each additional filter giving you another 25 dB rejection, but remember you can't reach extremely low levels of 60 Hz noise because the noise will re-enter your signal from other sources.

Now you have another modular instrument which I'm sure you'll find to be a useful addition to your lab. Note that for AC hum noise coming from power supplies that have full-wave rectifiers, the noise will be 120 Hz instead of 60 Hz. Filtering this noise will therefore require a notch filter designed for a center frequency of 120 Hz. **NV**

References

1. *Rapid Practical Designs of Active Filters*, David E. Johnson and John L. Hilburn, John Wiley & Sons, Inc., New York, NY, 1975.

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5. *The Biquad: Part 1 - Some practical design considerations*, L. C. Thomas, IEEE Transactions, Circuit Theory, vol. CT-18, pp. 350-357, May 1971.

6. *Analog Filter Design*, M. E. Van Valkenburg, Holt, Rinehart and Winston, Inc., Fort Worth, TX 1982.

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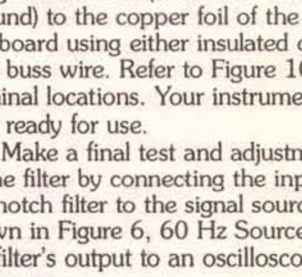

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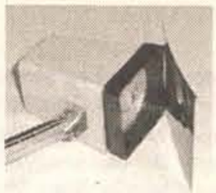
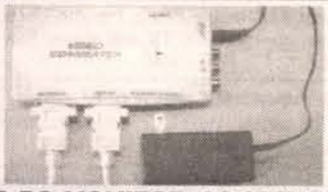
SCANNING MOTOR — A-330SC with universal mounting bracket accepts all standard 1/4 x 20 threaded CCTV cameras. No tilt, just PAN. 75 degrees of continuous motion with a scan rate of 5 seconds per cycle. 110 volt indoor operation, but can be adapted for outdoor use. Includes 12 foot power cord. Perfect solution to triple your effective camera viewing angle! **$39/each**, or **$25/each** in qty. of 4. Small size, 3-1/2"D x 2"H. MATCO, Inc., Schaumburg, IL. 1-800-719-9605. E-Mail: sales@mat-co.com Website www.mat-co.com



INFRARED FILTER ELIMINATES 99.9% OF ALL VISIBLE LIGHT — IR-9000.All B/W CCD cameras are IR sensitive. Place a 25 watt or less light behind the 3" x 3" filter, and you will see in the DARK. $18/each. Purchase 2 for $30. MATCO, Inc., 1-800-719-9605. E-Mail: sales@mat-co.com Website www.mat-co.com

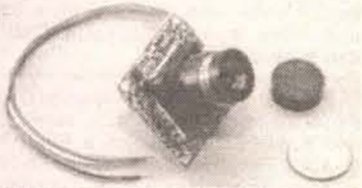
AS-1004, FCC approved. 2.4GHz transmitter & receiver with audio! Capable handling total of 4 wireless cameras, range: >300'. Built-in camera, 400 TV line. **$219 per system**. Additional cameras at **$129/each**. Matco, Inc. 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com

COUNTER-SURVEILLANCE=$250 HR! Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn **$250 HR** in the fascinating field of COUNTER-SURVEILLANCE! For FREE catalog call: **1-800-732-5000**. HTTP://WWW.SPY-CITY.COM



USE PC MONITOR AS SECURITY MONITOR. The VGA-801 accepts standard NTSC or PAL inputs for display on any existing VGA/SVGA computer monitor. Small compact size. Over 600 lines of resolution, twice that of standard TV monitor! **$69 each**. Dealers welcome. MATCO, Inc., 1-800-719-9605; Fax 847-619-0852; E-Mail: sales@mat-co.com Website: www.mat-co.com

QUAD VIDEO CABLE MODULATOR. CVS-600 inserts 4 color or black & white composite video signals on unused cable channels, 81 thru 95. Watch 4 remote security cameras from any TV in your home! Built-in signal amplifier and comb filter eliminates any ghosting and actually **IMPROVES** existing video! Only one unit needed with existing cable system. $199/each and **$169/each** in qty. of 4. MATCO, Inc., 1-800-719-9605. E-Mail: sales@mat-co.com Website www.mat-co.com



LOW VOLTAGE B/W high RES 430 line CAMERA with optional black low-profile swivel adjustable enclosure. Pin hole or Std. lens type. 6, 8, and 12mm lens are available. 1/3" CCD, 3.6mm/F2.0 lens included; works from **7.5-13 VDC**, highest voltage range in market. 0.08 lux, IR sensitive; 1.27" x 1.27" x 0.5"D pinhole or 1" deep standard. **$49 each** SPECIAL PRICE FOR JUNE. Enclosure: $8; optional lens: $18. Dealers welcome. MATCO, Inc. 1-800-719-9605. Fax 847-619-0852. E-Mail: sales@mat-co.com Website: www.mat-co.com

WEATHER RESISTANT OUTDOOR CAMERAS. WR-700 type, high impact tempered glass with stand. Black & white (430 lines), or color (420+ lines) available. Standard 3.6mm lenses with optional lenses of 6, 8, and 12 mm at $20 extra. **B/W $119/each. Color $179/each**. Small compact size with sun shield. MATCO, Inc., 1-800-719-9605. E-Mail: sales@mat-co.com Website www.mat-co.com

SURVEILLANCE-COUNTERSURVEILLANCE: I buy and sell used equipment. Steve 410-879-4035.

OPEN FRAME POWER SUPPLY

±15VDC or ±12VDC @ 5A. Power One HDD15-5-A, unused in factory box with full documentation.

20E009 $24.95 each

TV INTERNAL A-B SWITCH

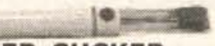
12VDC @ 15mA controls relay. Non-latching. Remotely switches between two 75Ω coax ports. Specs included.

98G001 $7.95 each

COMMON MODE FILTER

Toroid core with two 82µH windings. Rated 250VAC @ 2A.

97N006 89¢ each



SOLDER SUCKER

Small size makes for easy one-handed operation. Aluminum barrel with teflon tip.

20Z007 $4.99 each

BIPOLAR STEPPER MOTOR

12 VDC, 300 mA, 20 Ohms, 400 s/rev, NEMA-17 size. 3/16" x 1/2" splined shaft one side; 3/16" x 1/4" smooth shaft, other side.

97M018 $4.95 each

70 MHz DUAL I.F. BOARD

Two independent 70MHz IF strips on one board with ±12V regulators for each strip. Three demodulator sections per strip with 5 IF transformers, balanced mixers (MCL #SBL-1), two MC1496 ICs, 5MHz crystal. FM audio section with two LM3089 FM-IF IC and 10MHz crystal per strip. Lots of op amps (7 per strip), plus resistors, caps, inductors, transistors, sixteen 25-turn trimpots. All on 7" x 17" ground plane PC board with shield.

98G002 $24.95 each

6-METER FSK RECEIVER

Crystal controlled on 50.675 receive frequency. Superhet with 10.7MHz IF. Three ICs and one transistor. Not a kit! New, with schematics and spec sheet for major components.

92A067 $9.95 each

TELEPHONE SPEECH NETWORK

With Dialer Interface

Telephone line powered. Adjustable gain. Works with electret mike and receiver or earphone. Impedance 150 Ohms or higher. Provides regulated voltage for external CMOS dialer. With docs.

97V005 $4.95 each

BROADBAND RECEIVER RF PREAMP

Amplify received signals in the 5 to 900 MHz range with 10 dB gain. Will work with any shortwave receiver, scanner or TV.

92A025 $14.95 each

LASER DIODE

Toshiba TOLD9200. 670nm, 9mm dia. case, 3mW, 2V @ 80mA.

99S004 $14.95

PC MOUNT TRANSFORMER

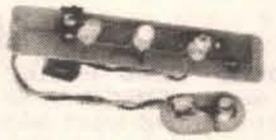
Input: 115/230 VAC @ 50/60 Hz. Output: 14VDC @ 4A or 28VCT @ 2A. Size: 2½"W x 3-1/16"L x 2"H. Class F-1.

20N002 $8.95

14-DAY PROGRAMMABLE TIMER

Originally used to control a satellite receiver through its IR port. Time on/off for eight distinct events. Modify it for your needs or dismantle it for its parts. Programmable with a 2732 EPROM in a removable "personality" module, the unit may be modified to control any IR device through its IR port. Contains Z80 CPU, clock display and associated parts. Operates from 9VDC 500 mA wall transformer which is included.

92V014 $9.95 each



FLASHING LED KIT

Three extra-bright LEDs flash in unison on this 9V battery powered board. Use as safety warning for auto or bicycle, party gimmick, sea buoy, etc. Kits may be used in parallel to form an array.

95K001 Parts Kit $3.95

LCD DISPLAY

Four lines by 20 characters. Back light attached. Standard 14-pin connection.

94L010 $14.95 each

CAPACITORS BY THE POUND

Lytics, tants, discs, glass, epoxy, computer grade. A good variety of all kinds of caps.

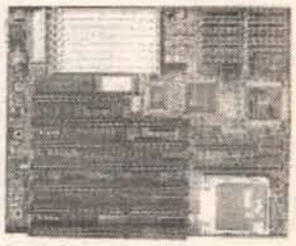
20P004 5 Lbs. for $9.95

New!

IBM TRAVELSTAR HARD DRIVE

3.25GB ATA/IDE, 5VDC @ 500mA, 4200RPM. 6304 cylinders, 16 heads, 63 sectors C/T, 2.5" form factor commonly used in laptops. Label has setup info. Model DBCA-203240, part 21L9530. More info is at <www.ibm.com/harddrive>.

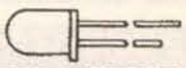
20C011 $99.95 each



'486 MOTHERBOARD

Comes wth a 25MHz 486-SX CPU. Board supports SX25, SX33, DX25, DX33, DX40, DX50, DX2-50, DX2-66, DX2-80. Does not support DX4 CPUs. All info silkscreened on board. Seven ISA slots and 2 VESA local buss extensions. Used, tested good. While supplies last...

98C014 $19.95 each



ULTRA-BRIGHT WHITE LED

T1¾ ultrabright white, 5600 mcd. *This will stun your eyes!*

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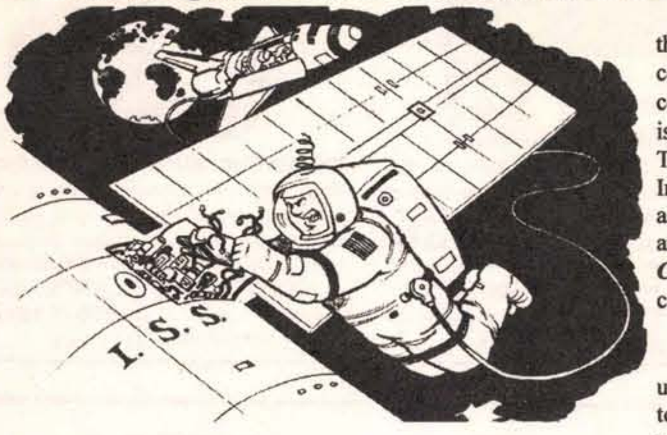
Callbacks up here can be a matter of life and death.



Technicians at NASA's Space Shuttle Logistics use the ***CapAnalyzer 88A*** to be sure equipment is in perfect condition before being launched where service calls could be somewhat of a problem. The ***CapAnalyzer 88A*** is also used by NBC TV, General Motors, Sears Service, Time Warner Communications, Panasonic, Matsushita Industrial, and Pioneer Electronics technicians, as well as thousands of independent TV, computer monitor, VCR and industrial service technicians. They prefer the ***CapAnalyzer 88A*** because it checks electrolytic capacitors for leakage and ESR *in-circuit*, accurately.

Check www.eds-inc.com/88users.html for actual users' comments as they compare their own ***CapAnalyzer*** to the "wizards" and "z-meters" they already own. No unsoldering to check out-of-circuit, no mistaking a shorted or leaky cap as good, as other "ESR" meters do, no guessing about whether a value is good or bad. With the exclusive three-color comparison chart right on the front panel, auto-discharge, multi-beep alert, and one-handed tweezer test probe, even your grandmother could find defective caps in that problem PWM power supply, TV, computer monitor, VCR, or industrial control board in just seconds. And because it's handheld you can service anything anywhere. It's no wonder that almost 60% of ***CapAnalyzer*** sales are by referrals, or service managers buying additional units. In fact, our distributors tell us it's the most asked-for-by-name piece of test equipment they sell.

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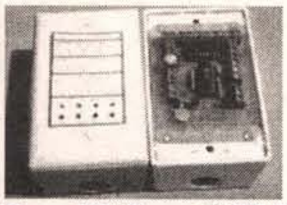
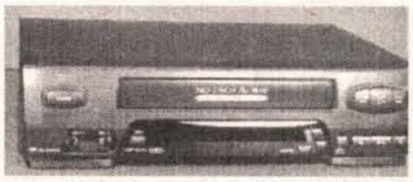


VIDEO TAPE INTRUDERS CAR/HOME. 2-zone alarm system sends remote control commands (on, record, stop, off) to your VCR. Warning & alarm zones. Includes UL singlegang box & cover, circuit board, and emitter cable. Requires 12V DC. **VSS-1 $99**. www.burglarvideo.homestead.com to download manual. Dealers welcome. Fax 310-545-5958.

CCD BULLET CAMERAS B/W & COLOR. AX-800 series, weather resistant high impact design with swivel bracket. Will work with Matco's scanning motor. 3/4" diameter x 3" long approx. B/W: 400 line/0.2 lux. **$89/each**. Color: 350 lines/2 lux, **$139/each**. MATCO, Inc., 1-800-719-9605. E-Mail: sales@mat-co.com Website www.mat-co.com

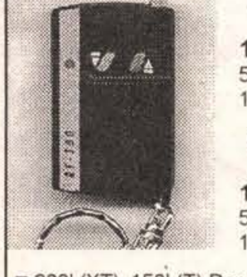


40 DAYS and 40 NIGHTS RECORDER. TLR-6960 time lapse, can be activated by either contact closure or continuous duty operation with standard T-120 tape. Special price **$499**. Matco, Inc., Schaumburg, IL 1-800-719-9605. E-Mail: nsales@mat-co.com Web site www.mat-co.com

www.nutsvolts.com

Miniature Transmitters and Receivers

2 Button / 3 Channel Transmitter



RF300T

1....$22.95
5.....$19.95 ea
10...$16.95 ea

RF300XT

1....$25.95
5.....$22.95 ea
10...$19.95 ea

- 300' (XT), 150' (T) Range
- Frequency: 318 MHz
- 59,049 Settable Security Codes
- 12 Volt Battery and Keychain Included
- Current Draw: 4.8 ma
- Fully Assembled in Case
- Dimensions: 1.25" x 2.0" x .5"
- Push both buttons for the 3rd Channel
- Slide Button Cover Included

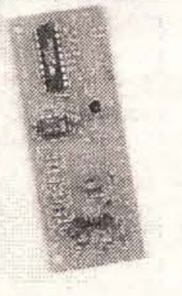
4 Button / 15 Channel Transmitter

RF304XT

1....$27.95
5.....$24.95 ea
10...$21.95 ea

- 250' Range
- Frequency: 318 MHz
- 6,561 Settable Security Codes
- 12 Volt Battery and Keychain Included
- Current Draw: 4.6 ma
- Fully Assembled in Case
- Dimensions: 1.35" x 2.25" x .5"
- Push combination of buttons to achieve up to 15 channels

2-4 Data / 3-15 Channel Receivers



RF300RL
RF300RM

1....$27.95
5.....$24.95 ea
10...$22.95 ea

RF304RL
RF304RM

1....$29.95
5.....$26.95 ea
10...$23.95 ea

- Compatible with 300/4 Transmitters
- 11-24 volts DC Operating Voltage
- 13 ma. Current Draw
- Latching (L) or Momentary (M) Output
- Kits Available (subtract $5.00 ea.)
- Dimensions: 1.25" x 3.75" x .5"
- 2 (300) / 4 (304) Output Data Lines
- Binary to Dec / Hex Converter can achieve up to 15 channels

- Alarm Systems
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- Lighting Control
- Magic Props
- Medical Alert
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- Custom Design Consulting Available

Visitect Inc. (510) 651-1425 Fax: (510) 651-8454 Email: Support@Visitect.Com
P.O. Box 14156, Fremont, CA 94539 Visa / Mastercard, COD

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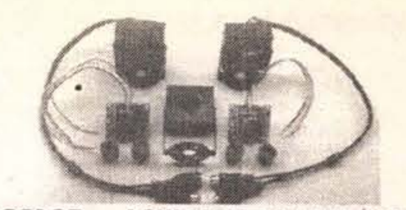

COLOR — LOW LIGHT 2 LUX CCD pin hole and standard lens available, only 1.37" x 1.37". **$109** each, enclosure $10 extra. Sony sensor. Matco, Inc., 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com

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SEE ADMART SECTION, pages 77 and 78 for other MATCO products, including wireless systems.

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WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

FREE FLYER on DBS files, hacking, hardware info. Smart card socket $5 ea. New Atmel 89C52 $10 ea. Bill 1-800-879-9657.

THE EASIEST way to recover your lost master code. 16C5X, 16C62X, PALS, GALS, other microcontrollers, custom ASICs. Chip readers and other custom hardware. Check out our web page at www.acdinc.com for details or call 703-764-5361 or write Advanced Circuit Designs, Inc., 5765-F Burke Centre Parkway #317, Burke, VA 22015.

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LIQUID CRYSTAL DISPLAYS

240x64 dot LCD with built-in controller.

AND 4021ST-EO. *Unit is EL back-lit.* **$59.⁰⁰ or 2 for $109.⁰⁰** *or*
OPTREX. DMF5005 *(non back-lit)* **$49.⁰⁰ or 2 for $89.⁰⁰**
20 character x 8 line
7¾L x 2¾H
The built-in controller allows you to do text and graphics.

Alphanumeric—parallel interface

16x1 .... $6.00	20x2 .... $8.00	32x2 .... $8.00
16x1 (lg. char.) $8.00	20x4 .... $8.00	40x1 .... $8.00
16x2 .... $6.00	20x4 (lg. char.) $10.00	40x2 .... 2 for $20.00
16x2 (lg. char.) $10.00	24x2 .... $8.00	40x4 .... $20.00
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5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • ***Certain models are backlit, call for more info.***

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	$20.00	480x128	Hitachi	$10.00
640x400 (backlit)	Panasonic	$15.00	256x128	Epson	$20.00
640x200	Toshiba	$15.00	240x128 (backlit)	Optrex	$20.00
480x128 (backlit)	ALPS	$10.00	240x64	Epson	$15.00
			160x128	Optrex	$15.00

6" VGA LCD 640X480, Sanyo LMDK55-22 **$19⁰⁰**

MONITORS

9" COLOR SVGA MONITOR $169.⁰⁰
Fully Enclosed – Tilt and swivel type.

MONITORS

Non-Enclosed TTL

Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.
5 inch Amber $19.00 • 7 inch Amber $19.00
9 inch Amber or Green $19.00

5" COLOR MONITOR $29.⁰⁰

2 for $49⁰⁰

• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible
• 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq.
• Open Frame Construction • Standard Interface Connector • Degaussing Coil included • Mfr. Samtron

HACKER CORNER

EMBEDDED 486 COMPUTER

$79⁰⁰ 2 for $149⁰⁰

Complete enhanced Intel 486SX-33 based computer in ultra small (9-7/8L x 6-5/8W x 3-1/8H) case. Ideal for embedded operations or as a second computer. Features include: • One 16 bit ISA slot • 3 serial ports plus dedicated printer port • Parallel optical coupled adapter port • Built in IBM PC/AT keyboard port • On board VGA video and port • Uses standard SIMM up to 32 MB • BIOS is PC/AT compatible

Unit has a backup Ni-Cd battery system in case of power failure (5 min. backup time) and lockable front cover to prevent floppy drive access. Mounting / interface provisions for standard 3.5" laptop floppy and 2.5 inch hard drives. Comes with very comprehensive manual.

NTSC COMPOSITE 4" LCD MONITOR $69⁰⁰

ROCKWELL™ "JUPITER" GPS RECEIVER $69.⁰⁰

Miniature (2.75" x 1.5" x .25") 12 channel receiver engine • Supports NMEA 0183 and binary protocols • Supports DGPS input in both protocols • Compatible with active and passive antennas • "Keep-Alive" reduced power capability • Standard 2mm 2x10 interface connector • Complete manual and interface documentation available • Compatible with most laptop software using NMEA interface • Suitable for wide range of GPS applications including: Handheld GPS, Automotive / Marine / Aviation Applications, Amateur APRS and Packet.

SONY Miniature Color LCD Display (LCX005BKB) $29⁰⁰

• 1.4 CM (0.55 inch) Diagonal Full Color Display • Built In Horizontal and Vertical Drivers • Delta Dot Pattern for High Picture Quality - 537 dots (H) x 222 dots (V) • Compatible with NTSC & PAL Format and Sync Inputs • 12 VDC Operation with -1 to +17 V RGB Signal and Driver Input Voltage • Excellent Display for Virtual Reality Projects, Viewfinders, and Miniature Test Equipment Displays • Pin Outs and Specification Included • Unit Requires Clock, Synchronization and Video

1.8cm (0.7 inch) unit LCX009AKB 827H x 228V **$29⁰⁰**

CELL SITE TRANSCEIVER $29⁰⁰ 2 for $49⁰⁰

These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

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WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

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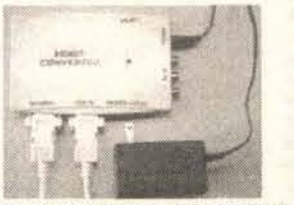

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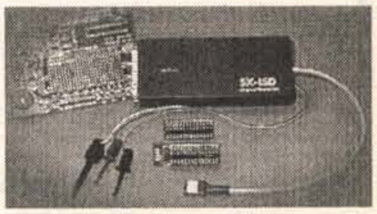
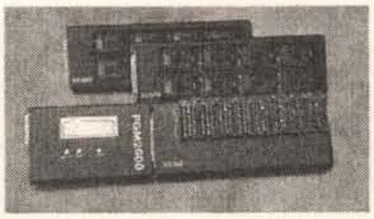


Also Available...



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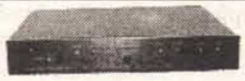

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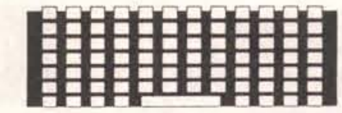
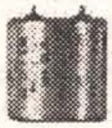


Geophone

vibration sensing kit



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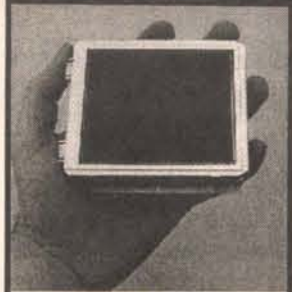

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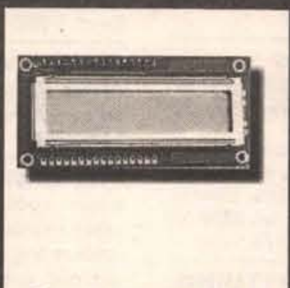

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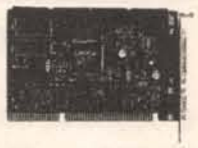

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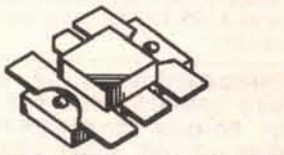

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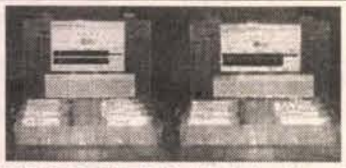

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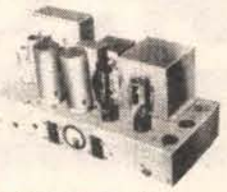

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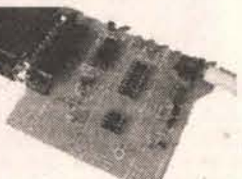

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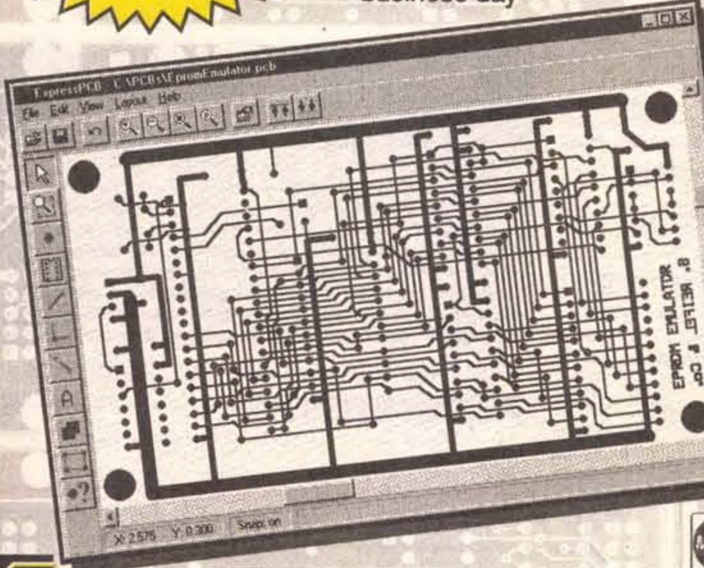

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Questions & Answers

TECH FORUM

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QUESTIONS

Send all material to **Nuts & Volts Magazine**, 430 Princeland Court, Corona, CA 92879, OR fax to (909) 371-3052, OR E-Mail to **forum@nutsvolts.com**

Does anyone know of a circuit I can build, that will allow me to determine the specific percentage of pure silver dissolved in distilled water, by electrical means?

I am trying to find the percentage of the processed silver for a given amount of water, by volume, after processing. I wish to measure the percentage of the final colloid silver solution.

9001 **Antonio J. Anzevino**
Wappingers Falls, NY

I eat in a crowded dining room and am extremely hard of hearing. I'm interested in obtaining information, plans, etc., for a device to be used as a transmitter to my headphones. The transmitter could be in my shirt pocket and receiver in the same case.

9002 **Vernon A. Rodgers**
Venice, FL

I have a medium-sized satellite dish. I would like to make a parabolic microphone out of it. I need plans and information on what kind of microphone and amps to use?

9003 **Eric Hado**
Hopewell Junction, NY

Does anyone have information on how to build ferrite antennas for the AM broadcast band and the shortwave bands?

9004 **Marvin Rosen**
Baltimore, MD

Can the small bobbin-shaped and cylinder-shaped fixed inductors found in abundance in computer monitors and modern day TVs be used as "RF chokes" in radio receiver/transmitter construction projects?

These small inductors (about 1/4" to 5/8" in diameter and about 1/2" to 1" long) measure less than 1 uH to over 15 mH (RCL meter) and appear to be wound on a non-metallic (ferrite?) core and with DC resistances of milliohms to several ohms.

With a lab full of test equipment, including a research grade Q-meter, how do you test the appropriateness of these inductors for radio receiver/transmitter construction projects?

Also, what is the purpose of the small disk-shaped permanent magnets attached to one end of some of these inductors? I have found that by removing the magnet, the inductance (RCL meter) increases.

9005 **Ted Roubal**
Shoreline, WA

I am looking for a circuit that is run from a 12VDC gel-cell or car battery. The application is for my RC gas powered car. I need one circuit to be 1.5 volts and be able to provide up to 4-5 amps. I will need to be able to adjust the current to the glow plug due to the change in resistance when it is hot, and if it is not a real big deal have a meter in the circuit so I can monitor the current flow and adjust it as needed.

The second circuit is to charge the AA batteries in the controller and receiver in the car. It needs to be run from the same 12VDC.

9006 **Tony Pugh**
via Internet

Some time back, I bought an Apple "clone" ... the first company licensed by Apple, I believe. It's a power computing corp. "PowerBase 180," 1.2GIG HD, 8X CD-ROM, 32 meg of RAM.

I love the system, except that it didn't come with any manuals, or software (i.e., CD, floppies, etc.). It has an IDE HD, with a SCSI CD-ROM. I could live without the TMs probably, but I really need the system disk.

9007 **Anonymous**
via Internet

Please give me a source of a wiring diagram for a DC power supply for a Hewlett Packard Laserjet series II printer.

9008 **Leland Glenn**
Fort Myers, FL

I am looking for the vendor(s) that are producing the DIY Solar Charge Controller/Monitor PC board described in your April 1997 issue of *Nuts and Volts*. I have already attempted to contact Circuit Designs of Central Point, or the original vendor listed as a source in the article. The phone is disconnected and I don't hold out much hope for a response from their mailing address. Is someone else producing the PC board?

Any help will be greatly appreciated.

9009 **James Vrzal**
Holiday, FL

ANSWERS

ANSWER TO #8003 - AUG 2000

In answer to #10011, Jan. '00 regarding a schematic/SW to allow the PC via its parallel port to connect to a GPIB device. The reply cited "plotgpib.zip" a shareware product.

I have looked many places in a lot of shareware cites (shareware.com, tucows.com, etc.), and have come up empty.

Can someone please come up with a more definite location for this software?

Some years ago, I found some source code that twiddles the PC parallel port to simulate an IEEE-488 controller. I fixed a problem in it, then lost track of it. But Stan Eker reposted it on Usenet, and even had my bugfix! So I've put it up here in the hope that it will be easier to find.

There are some limitations — it can only drive one or two devices, it may need a modified parallel port (I recommend that you use a cheap card, not a motherboard port), and is probably rather processor speed dependent. I last used it on a 12MHz 286. I doubt that it will work under Windows, but that might be a blessing.

Sources and documentation can be found in plotgpib.zip

Ed Bell
Colchester, VT

ANSWER TO #8005 - AUG 2000

I have an old DOS graphics program that uses printer control codes to control an NEC PC-8027 printer. This application was written for a DEC PDP-11 (RSX-11M), which runs from DOS via a Strobe Data Osprey emulation board. The application was written by Minato (Japanese tester company), which has since been purchased by Ando. The printer is no longer supported by NEC and there's no new source code available for the program. Of course, it's a program that I still need to use. Is there a hardware or software means of translating the printer control codes from this printer to a more modern one? I thought of using an EPROM decoder or a TSR patch.

The easiest way to run a "lega-

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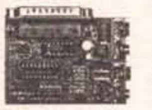

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cy" application such as your DOS graphics program, is with the legacy hardware it ran on. If that equipment cannot be repaired, then the next best bet is to get the code to at least load on a new DOS system.

If the application is a single "EXE" executable file and is not too big, then you could load it under DEBUG and patiently trace through its operation until you find exactly what control sequences it is sending out. It would help if you know exactly what control sequences the old NEC printer used; for then you would know what to look for.

Once you have documented the old sequences and the places in the program where they occur, and you have in hand the document that tells you the corresponding sequences for the new printer that you want to use, then you can, in principle, patch the code to send out the new sequences.

If it turned out that the old sequences and the new sequences are exactly the same length, and there is one-to-one correspondence between what you have and what your need, then an EPROM translator might actually work.

If the DOS program is writing directly to the printer port, then it is not so obvious how you would slide a TSR wedge in under it so as to intercept and translate the bytes it is sending out. On the other hand, if it is calling DOS via Int 21H or calling the BIOS via Int 17H, to send its stuff to the printer, then a TSR probably could handle the translation.

What typically happens in practice, of course, is that the DOS graphics program is too big to load under DEBUG, or it was deliberately designed to discourage any attempt to "reverse engineer" the code. In that event, the remaining easy way is to take out a clean sheet of paper and write yourself a nice new program that does things the way you want them done.

Such labors, of course, will also help you to acquire new appreciation of the Linux open source movement. You really should have the source for the programs you depend upon. As time goes on and Linux becomes the standard operating system, there will be far less justification for allowing ourselves to be locked in the "byte" you are now in.

Jack Dennon
Warrenton, OR

ANSWER TO #8002 - AUG 2000

Does anyone have a full service (POP3/SMTP) bios tweak for the Mail Station?

There are ways to tweak the mail station depending on which revision you have. There is an Internet discussion board for discussing modifications to a variety of devices at **www.kenseglerdesigns.com/cgi-bin/UltraBoard/UltraBoard.pl.**

You'll find a link to the mail station discussions on that page.

Doug Smith
Via Internet

ANSWER TO #80015 - AUG 2000

How can I access the Internet over my Motorola bagphone?

Since you refer to a Motorola bagphone, I'm going to assume you've got an older analog model in the order of the 3000 series.

Moto has a small black box called The Cellular Connection (S-1936). Electrically, it installs in series between the control head and the radio itself. Physically, it can be mounted under the handset bracket, (the holes line up).

A most interesting device; it's got an RJ-11 port that will accept a standard telephone, fax machine, or computer modem. The Connection translates telephone DTMF tones and loop signalling to the serial data stream used by the cell phone. It also generates "ring battery" on an incoming call and splits the telephone audio into the appropriate land-mobile and mobile-land paths for the radio circuit.

Ideally, you would unplug your computer modem from the wall jack and plug it into the Connection. Your modem would go off-hook,

ANSWERS TO #8007 - AUG 2000

I am desperately looking for a way to control a residential bath fan/light unit. It is now wired on one switch. I am seeking a way to control them independently while using the existing wiring which is two wires (only one load wire).

I have seen such a unit for paddle fans, but I can't locate one for exhaust fans. None of the major electrical manufacturers I contacted were any help.

#1 You want to control more than one electrical device with only one set of wires. This is easily done using X-10 or X-10 compatible controllers and devices. Basically, you leave the power on all the time.

Put a two- or four-device controller (it looks like a switch) where your current switch is and get separate power controllers for the light and for the fan motor.

There are several different models, florescent light or incandescent, relay (motor), and dimming.

You can see the X-10 stuff at www.x10.com, but my favorite place is **SmartHome.Com** (company name and web site). They have a great catalog with almost 50 pages of X-10 and many X-10 compatible devices. If you don't have access to the internet, you can call for a catalog at **1-800-762-7846**, 24/7.

Randy Boettjer
Oak View, CA

#2 Having worked in a lighting store, this is not an uncommon question.

Most ceiling (paddle) fans can have both the motor and light controlled by the same potentiometer/switch using two wires (one load and one neutral). But the motor speeds up as the light brightens. So most opt for a separate load wire and dimmer/switch for the light.

To control each individually with one load wire, a transmitter and receiver with two channels is needed. It would work much like an X10 unit, or use RF. I can imagine it working with an exhaust fan, but have not tried it.

A more common approach (for short distances) is to fish a new load wire through the ceiling and down the wall to the switch box, replacing the single switch with a dual switch. If there is no attic, the wire can jump into the room around the ceiling/wall corner and then back into the wall, fitting into a groove that will be plastered and painted. This method can also be used if the joists block a direct path. An electrician is usually able to find a method to do this. The wire can also be hidden using moulding. Fancy moulding can spice up a plain bath!

A common approach is to add a pull chain switch to the light/fan cover for the fan, which won't run if the light is off.

Another method uses an X10 module and wall switch or controller unit. This gets a little more complicated since X10 doesn't have a relay module that responds to lamp on/off that I know of (and needed).

Or, a special relay can be put in the fan/light that cycles each time the wall switch if flipped on: light, then fan, then both. A different version has the relay with off as a forth position, and replacing the wall switch with a normally open push button, but works only if both switch wires run back to the fan/light.

And then there are the wireless switch products where the switch has a battery and gets attached to the wall while the (motor rated/relay) receiver gets put into the housing to control the fan.

Rick Detlefsen
Austin, TX

Write In 62 on Reader Service Card.

TECH FORUM

hear dial-tone, DTMF out the number of your ISP and establish a session as usual.

We've found, though, that the quality of the cell call has a big influence on the throughput of the session. You will need to be stationary, with a very good cell signal or your session may collapse.

The Cellular Connector works only with the older Moto phones, but there is (or was), a similar system put out by Telular that interfaced to a number of non-Moto cell phones.

However, if you're doing a lot of mobile computing, you might consider Cellular Digital Packet Data. CDPD is a service offered by a number of cellular service providers that provides Internet access directly over the cellular system. One or more channels in each cell site may be dedicated to the service or the system may use a "sniffing and hopping" technique to send a quantity of data on an idle voice channel, then quickly hop to another idle channel when a voice call comes up, and resume sending packets.

CDPD-only modems are available in PCMCIA form factors, as well as a combination cellular voice/cellular modem/fax/CDPD unit.

Rusty Schwarz
River Vale, NJ

ANSWERS TO #8009 - AUG 2000

LM3909 is an LED blinker chip, it is being discontinued. Jameco sells them for about $5.00 a piece now. Does anyone know of any replacement LED blinker chip that sells for a reasonable price? RadioShack no longer carries LM3909. (I do not have a computer.)

#1 The LM3909 is available for $0.99 each from the nice people at:

B.G. Micro
555 N. 5th St., Suite 125
Garland, TX 75040
1-800-276-2206
972-205-9447
http://www.bgmicro.com/

It would be a good idea to stock up since National Semiconductor no longer makes this part.

David DiGiacomo
San Francisco, CA

#2 I too needed to refill my stock of LM3909 flasher chips, and was surprised to find it discontinued. I would have been happy if I found 1.5 volt flasher LEDs, but the closest was almost three volts.

An Internet parts search indicated that many vendors had almost 5000 available, but how accurate is that? I went down my list of suppliers that listed the part, only to be told it was no longer available. I then tried Unicorn Electronics that at least said 'back ordered.' They arrived about a week later. They cost $1.09 each at the time (plus shipping and any tax). So I'm set.

Another method offered in Nuts & Volts (March 2000 issue page 74), was to use an ICL7660 voltage doubler chip to run a three-volt flasher LED, or use two to run a six-volt flasher LED. For twice the current price, this will work. Using the SMD version will make for a tiny package.

Some say this chip is obsolete, but it's just discontinued as nothing better is available to replace it (the word obsolete needs to become obsolete!). Nothing matched this chip in voltage, versatility, parts count, and price. I think only the 555 had more articles and circuits published. I have projects that run on 1.5 volts and this chip was ideal. I may use the voltage doubler in the future and save this chip for its many other uses.

Rick Detlefsen
Austin, TX

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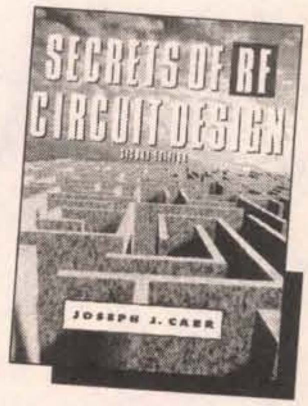

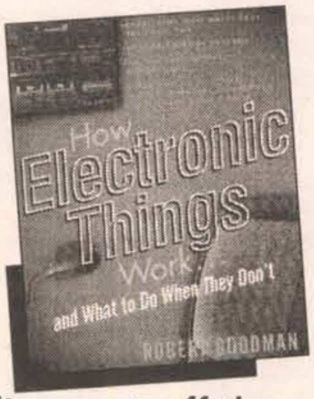

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by Tim Deagan

Taking Things Apart:

The Joy of Microcontroller Disassembly

Part 2

A PIC 16C84 Disassembler in Python

In Part 1 of this article, we examined how disassemblers work, describing the basic functions needed to disassemble Intel INHX8M Hex files for the PIC 16C84. We examined what is possible with multiple disassembly passes.

In Part 2, we'll actually write code to implement the functions we described in Part 1. So, let's fire up our source code editors and get to work!

The very first thing to do is choose a language and there is no shortage to choose from. Selecting one can be difficult. I adopted the following criteria for my choice:

- Very low cost or free.
- Very easy to learn.
- Has a future.
- Well-supported with lots of free code and documentation.
- Has an active online developer community.
- Has solid development and debugging tools.
- Multi-platform.
- Powerful.

Surprisingly enough, this leaves a number of contenders still standing. But among them is one very special language: Python.

Python, created by Guido van Rossum and named after Monty Python, is a language that everyone will be hearing about in the next few years. It meets or exceeds all my criteria, as well as bringing some additional strengths to the table. Python is fully object-oriented. Python is amazingly easy to maintain; the very structure forces different programmer's code to look similar. This makes it very easy to look at someone else's code and reuse or support it – a major problem with other popular languages.

Python is used by some very large companies who describe their use of Python as a major competitive advantage. Industrial Light and Magic – the special effects wizards behind *Saving Private Ryan* and *Star Wars Episode 1 – The Phantom Menace* – are one of the companies who believe that Python makes them dramatically more productive.

Python is also easy to learn. It has been chosen as the language for a major new government program, "Computer Programming for Everyone" (CP4E), that intends to teach script level programming to middle-schoolers in the next few years.

Python can be used at a variety of levels. You can develop in it using classes and methods, taking advantage of object-orientation (OO). You can use it like a non-OO language, taking advantage of modules in hierarchically separated files. Or, you can write simple programs in it as if it were a script file.

To keep the usage as straightforward as possible for readers new to Python, I am keeping all of my code in a single, non-OO file. I do take advantage of functions within the file and standard library modules (one of the major reasons for using Python), but all of the disassembler code resides in one place.

Designing a Disassembler

To define what we want to build, it helps to start with requirements. These should describe – from the point of view of the problem not the solution – what we want the program to do.

1. We want the program to read Intel INHX8M Hex files.
2. We want the program to turn the hex file into readable assembly language.
3. We want the program to translate register addresses into readable names.
4. We want the program to translate jump targets from addresses to readable names.
5. We want the program to insert the jump target names as labels in front of the target lines referred to.
6. We want the program to create a symbol table.
7. We want the program to output the results somewhere easy to use.

This is a good high-level set of requirements. Now we need to design some ways to accomplish these goals.

Python has some powerful internal constructs which we will take advantage of. Two of these are dictionaries and lists. A list is an ordered set of data elements. An example list could look like:

```
['A', 123, 'fred']
```

These data elements can be strings or numbers or even other lists. To use terminology from other languages, a list is an array. We can access the elements within the list using their index.

A dictionary is an unordered set of data elements comprised of a key and a value. The key can be any single data element; the value can be any element or set of elements such as a string or a list. An example dictionary could look like:

```
{'john':[14, 'blond', 78704],
'lisa':[27,'brunette', 32501]}
```

Other languages refer to dictionaries as hash tables or associative arrays. Items within dictionaries are accessed by their keys.

We need some structure to store the data we derive from the hex file. This structure should support the activities we want to perform. We can use a dictionary very easily for this purpose.

Each entry in the dictionary will represent one line from the assembly code. The key to each dictionary entry will be the address of the line. The value will be a list of the additional fields we want associated with that address. Lists in Python are surrounded by square brackets and dictionaries are surrounded by curly brackets. A colon separates the key from the value.

Our structure for holding the disassembly data looks like this:

```
{lineaddr:[hexval, labelname,
```

Python Resources

A brief selection of Python books

Python Programming on Win 32
By Mark Hammond, Andy Robinson
O'Reilly & Associates
ISBN: 1-56592-621-8

The Quick Python Book
By Daryl Harms, Kenneth McDonald
Manning Publications
ISBN: 1-884777740

Python Essential Reference
By David Beazley
New Riders
ISBN: 0-73570-901-7

Python on-line
All things Python – www.python.org

PIC Resources
Microchip – www.microchip.com
The PIC archive – http://come.to/thepicarchive

Microchip Net Resources –
http://www.geocities.com/SiliconValley/Way/5807/

Source code URL
http://www.vex.net/parnassus/apyllo.py?i=42596071

Listing 1 — A PIC 16C84 disassembler written in Python.

```python
#!/usr/local/bin/python
##########################################################################
# PIC16_disasm.py
# V 0.3
# 9/99 - Tim Deagan
#
#     Disassemble an intel hex file for a PIC 16Cxx microcontroller.
#
#     asmlist format: {lineaddr:[hexval,
#                                labelname,
#                                mnemonic,
#                                arg_one,
#                                comma,
#                                arg_two,
#                                comment]}
#
##########################################################################
import os,string,sys # import the modules we'll need throughout

Dbug = 0                  # set to 0 to turn off additional debug output
code_limit = 0x1fff       # upper range in memory for code
hexcode = {}              # init some global data structures
asmlist = {}
# setup the register lookup table
reglist={
    0x00:"IND0",
    0x01:"TMR0/RTCC/OPTION",
    0x02:"PCL",
    0x03:"STATUS",
    0x04:"FSR",
    0x05:"PORTA/TRISA",
    0x06:"PORTB/TRISB",
    0x08:"EEDATA/EECON1",
    0x09:"EEADR/EECON2",
    0x0A:"PCLATH",
    0x0B:"INTCON"}

# asmlist format: {lineaddr:[hexval,labelname,mnemonic,arg_one,comma,arg_two, comment]}
# setup variables as their indices for readability in some functions
hexval = 0
labelname = 1
mnemonic = 2
arg_one = 3
comma = 4
arg_two = 5
comment = 6

##########################################################################
def hexlineparser(line):
    "Parse an Intel Hex File line into a dictionary"
    hexlen = line[1:3]       # number of data bytes on the line
    hexaddr = line[3:7]      # starting address of data on line
    hextype = line[7:9]      # 00 - data, 01 - eof
    hexdata = line[9:-2]     # data bytes (use words for the 14 bit PIC instructions)
    hexcrc = line[-2:]       # crc of line

    linelen = hexish(hexlen)           # decompose line length
    lineaddr = hexish(hexaddr)         # decompose starting address

    if hextype != '01':                # if not eof
        for i in range(0,linelen,2):   # grab each data word
            hexcode[lineaddr + i] = hexdata[i*2:i*2+4]   # populate dict. with addr:data

##########################################################################
def hexcodeparser_pass1(i):
    "Parse a dictionary of machine hex into Assembly language"
    hexval = hexcode[i][2:4]+hexcode[i][0:2]      # flip LSB,MSB to MSB,LSB
    hinibble = hexish(hexval[0]) & 0x03           # get 2 bits (00xx000000000000)
    lineaddr = i/2                    # make byte addresses into word addresses
    labelname = ""                    # initialize values
    mnemonic = ""
    arg_one = ""
    comma = ""
    arg_two = ""
    comment = ""

    if lineaddr <= code_limit:        # make sure we're parsing within the code space
        # for comment readability I'll number the 14 relevant bits of the 16 bit word
        # 0 - 13 with 0 being the least signficant bit
        if hinibble == 0:             # one major group starts with 00 as bits 12,13
            znibble = hexish(hexval[1])                     # get bits 8 - 11
            de_zero = (hexish(hexval[2]) >> 3) & 0x01       # get bit 7
            fi_zero = hexish(hexval[2:]) & 0x7f             # get bits 0 - 6
            de_print = ["W","F"]                            # setup target names

            if znibble == 0:          # subgroup of instructions based on bits 8-11
                if de_zero:                                 # if bit 7 is 1 then
                    mnemonic = "MOVWF"                      # it's MOVWF
                    arg_one = reglistlookup(fi_zero)        # resolve the address
                else:                                       # bit 7 is 0, so...
                    zero_ops = ["NOP","?","?","SLEEP","?","?DATA?","?",
                                "CLRWDT","RETURN","RETFIE"]
                    # it's one of these instructions. I used question marks since there
                    # are no operands for those indexes and I wanted to use a simple list
                    lb_zero = hexish(hexval[3:])            # check bits 0-3
                    mnemonic = zero_ops[lb_zero]            # use result as index to instr.

            elif znibble == 1:  # Check next value of bits 8-11
                zero_ops = ["CLRW","CLRF"]                  # setup instruction list
                mnemonic = zero_ops[de_zero]       # choose instruction based on bit 7
                if de_zero:                                 # if bit 7 = 1
                    arg_one = hex(fi_zero)          # there is an arg., get its hex value

            elif znibble >= 2:                      # check next value of bits 8-11
                zero_ops = ["SUBWF","DECF","IORWF","ANDWF","XORWF",
                            "ADDWF","MOVF","COMF","INCF","DECFSZ",
                            "RRF","RLF","SWAPF","INCFSZ"] # setup instruction list
                mnemonic = zero_ops[znibble - 2]       # use value of bits 8-11 minus 2 as index
                arg_two = de_print[de_zero]           # use bit 7 to get 'W' or 'F' as 2nd arg.
                comma = ","                        # put a comma between arguments
                arg_one = reglistlookup(fi_zero)      # resolve the address

        elif hinibble == 1:       # check the next value of bits 12-13
            one_ops = ["BCF","BSF","BTFSC","BTFSS"]             # setup the instruction list
            op_one = (hexish(hexval[1]) >> 2) & 0x03            # turn bits 10-11 into index
            mnemonic = one_ops[op_one]                          # get the instruction
            fi_one = hexish(hexval[2:4]) & 0x7f                 # bit number to test is bits 7-9
            arg_one = reglistlookup(fi_one)                     # resolve the address
            comma = ","                            # put a nice comma between args
            arg_two = hex((hexish(hexval[1:3]) >> 3) & 0x07)    # file to test is bits 0-6

        elif hinibble == 2:       # check the next value of bits 12-13
            two_ops = ["CALL","GOTO"]                           # setup the instruction list
            op_two = (hexish(hexval[1]) >> 3) & 0x01            # index is bit 11
            mnemonic = two_ops[op_two]                          # get the instruction
            ad_two = hexish(hexval) & 0x7ff                     # jump address is bits 0-10
            arg_one = hex(ad_two)                               # cleanup the jump target

        elif hinibble == 3:       # check the next value of bits 12-13
            # this one is extra funky since there are a buch of 'don't care' bits among the
            # distinguishing bits.  They are all least significant bits, so I use a greater
            # than or equal statement to find them.  I used two lists instead of a dictionary
            # to skip the xxx.keys(), xxx.sort() and xxx.rev() steps, since I needed them to
            # to be sequenced in my specific order rather than a sorted order.
            three_ops = ["ADDLW","SUBLW","XORLW","ANDLW",
                         "IORLW","RETLW","MOVLW"]               # setup instruction list
            three_keys = [14,12,10,9,8,4,0]           # setup values to map to instructions
            op_three = hexish(hexval[1])              # distinguishing bits are bits 8-11
            arg_one = hex(hexish(hexval[2:]))         # literal is bits 0-7
            for j in three_keys:                      # walk through the key values
                if op_three >= j:                     # if the distinguishing bits >= key
                    mnemonic = three_ops[three_keys.index(j)]   # grab the instruction that maps
                    break                                       # jump out of this loop

    asmlist[lineaddr]=[hexval,labelname,mnemonic,arg_one,comma,arg_two,comment] # create dict entry

##########################################################################
def hexcodeparser_pass2():
    "Second pass Disassembly parser, replaces CALL and GOTO args with labels"
    target_hold = {}                            # init place to hold targets
    target_count = 0                            # start with a 0 target count
    addrlist = asmlist.keys()                   # get addresses from the first pass dict.
    for test_addr in addrlist:                  # walk the addresses
        test_list = asmlist[test_addr]          # get the details for the test address
        if test_list[mnemonic] == 'GOTO' or test_list[mnemonic] == 'CALL':    # look for jumps
            test_target = string.atoi(test_list[arg_one],16) # turn the target address into a key
            target_list = asmlist[test_target]       # get the details of the target
            if not target_hold.has_key(test_target):   # if we haven't done this target...
                target_count = target_count + 1             # inc the target count
                target_hold[test_target] = target_count     # add a target dict entry
                target_list[labelname] = "TARG_" + str(target_count) # a unique label for target
                asmlist[test_target] = [target_list[hexval],       # rebuild target dict entry
                                        target_list[labelname]+":"
                                        ] + target_list[mnemonic:]
            test_list[arg_one] = target_list[labelname] # change the test line's jump to label
            asmlist[test_addr] = test_list                  # rebuild the test dict entry
            if Dbug: print ".",                  # if debugging, print a timing dot
    return target_hold                           # send back the list of targets

##########################################################################
def print_listing():
    "Output pretty disassembly and symbols"
    codebreak = 0                                # init some variables
    idbreak = 0
    configbreak = 0
    eeprombreak = 0

    # print listing from hex info
    addrlist = asmlist.keys()                    # get address list from dict
    addrlist.sort()                              # order it
    for addr in addrlist:                        # walk it
        if addr <= 0x1fff and codebreak == 0:    # address in code space?
            # layout header
            print "\nASSEMBLY CODE"
            print "-------------"
            print "ADDR WORD  LABEL   OPERAND  ARG1,ARG2"
            print "---- ----  -----   -------  ---------"
            codebreak = 1                        # don't print header again
        elif addr >= 0x2000 and addr <= 0x2003 and idbreak == 0:   # address is code ID?
            # layout header
            print "\n\nCODE ID(S)"
            print "----------"
            print "ADDR  WORD"
            print "----  ----"
            idbreak = 1                          # don't print header again
        elif addr == 0x2007 and configbreak == 0:       # address is the config word?
            # layout header
            print "\n\nCONFIGURATION WORD"
            print "------------------"
```

Continued

```
200         cfg = configworddecode(asmlist[addr][hexval])      # decode configuration word
201         wds = cfg.keys()
202         for wd in wds: print cfg[wd]                        # output configuration data
203         print "\nADDR  WORD"
204         print "—  —"
205         configbreak = 1                                     # don't print header again
206      elif addr > 0x2007 and eeprombreak == 0:               # address is eeprom data?
207         # layout header
208         print "\n\nEEPROM DATA"
209         print "————"
210         print "ADDR  WORD"
211         print "—  —"
212         eeprombreak = 1                                     # don't print header again
213      # Setup some comments
214      if addr == 0x0000:                                     # test for restart vector
215         asmlist[addr][comment] = ";Restart Vector"          # setup comment
216      elif addr == 0x0004:                                   # test for interrupt vector
217         asmlist[addr][comment] = ";Interrupt Vector"        # setup comment
218
219      # Output the line
220      print "%04X  %s  %-08s  %-06s  %s%s%s  \t%s" % tuple([addr,] + asmlist[addr])
221
222   # print symbol table header and info
223   print "\n\nSYMBOL TABLE"
224   print "————"
225   print "ADDR  SYMBOL"
226   print "—  ——"
227   # print labels
228   reportlist = target_hold.keys()                           # get list of target addresses
229   reportlist.sort()                                         # order them
230   for item in reportlist:                                   # walk them
231      print "%04X  %s%-12s" % (item,'TARG_', target_hold[item])  # output address and
                                                                      label
232   # print registers
233   portlist = reglist.keys()                                 # get list of known register labels
234   portlist.sort()                                           # order them
235   for item in portlist:                                     # walk them
236      print "%04X  %-17s" % (item,reglist[item])                # output address and label
237
238   print "\n"                                                   # end with a blank line
239
240 ######################################################################
241 def hexish(tohex):
242   "Change an ascii hex string to a hexadecimal integer"
243   return string.atoi("0x" + tohex,16)
244
245 ######################################################################
246 def reglistlookup(targetfile):
247   "translate hex to register name if appropriate"
248   if reglist.has_key(targetfile):          # determine if targetfile is a known address
249      return reglist[targetfile]            # if so, use the nice name(s) for it
250   else:
251      return hex(targetfile)                # otherwise use the hex value
252
253 ######################################################################
254 def configworddecode(cfgwd):
255   "translate the config word into list of flags"
256   cfgwdh = hexish(cfgwd)                                # turn ascii into hex
257   if (cfgwdh >> 4) & 0x01:cfg = "CP=on,"               # Code Protection
258   else:cfg = "CP=off,"
259   if (cfgwdh >> 3) & 0x01: cfg = cfg + "PWRT=on,"            # Power-up Timer Enable
260   else: cfg = cfg + "PWRT=off,"
261   if (cfgwdh >> 2) & 0x01: cfg = cfg + "WDT=on,"             # Watchdog Timer Enable
262   else: cfg = cfg + "WDT=off,"
263   if cfgwdh & 0x03 == 0: cfg = cfg + "OSC=LP"                # Oscillator Selection
264   elif cfgwdh & 0x03 == 1: cfg = cfg + "OSC=XT"
265   elif cfgwdh & 0x03 == 2: cfg = cfg + "OSC=HS"
266   elif cfgwdh & 0x03 == 3: cfg = cfg + "OSC=RC"
267
268   return cfg  # return the decoded values
269
270 ##################################################################
271 # main entry to the program
272 ##################################################################
273 if __name__ == '__main__':
274   for filename in sys.argv[1:]:            # do each passed file
275      print "\n"+filename                   # output file name
276      file = open(filename, 'r')            # open file
277      for line in file.readlines():         # grab each line from the file
278         hexlineparser(line)                # decompose into address:data
279      file.close()                          # close the file
280
281      addrs = hexcode.keys()                # grab keys (addr.) from line parser output
282      addrs.sort()                          # sort them
283      for i in addrs:                       # walk addresses
284         hexcodeparser_pass1(i)             # perform 1stpass disassembly
285      target_hold = hexcodeparser_pass2() # perform 2ndpass disassembly (label jumps)
286
287      print_listing()                       # output usable code to stdout
288      hexcode = { }                         # reinitialize storage
289      asmlist = { }
```

mnemonic, arg_one, comma, arg_two, comment]}

where lineaddr is the address of the line, hexval is the hexadecimal value of the instruction (opcode and operands), labelname is a label if the line has one, mnemonic is the instruction name, arg_one is the first argument, comma is a delimiter we'll use in printing if there are two arguments, arg_two is the second argument if one exists, and comment is a place to store comments we generate.

The PIC 16C84 microcontroller uses 14 bit instructions that contain an opcode and an operand. The opcode is the instruction name and the operand is the argument or arguments. Each instruction has a specific format of bits representing the opcode and the operands. To determine which instruction a given hex value represents, we must sort through the bits to first identify the instruction and then derive the arguments.

Most of the instructions are grouped together as blocks of similar bits. This allows a simple set of nested if statements to sequentially sort through the bits to arrive at the decoded instruction. Once the correct instruction has been determined, code unique to that instruction decodes the arguments.

We also have to be careful to only decode the values that are at addresses within the range defined as code for the microcontroller. Values outside this range represent items stored in EEPROM memory or system flags. We want to do a straight decode of these without trying to turn them into instructions.

We want to be able to read through the code and get a pretty good idea of what registers are being interacted with. The PIC 16C84 uses multiple banks of registers. Different registers have the same address, determining which register is being used requires knowing the state of a register bank flag.

To really know which bank is in use would require writing a microcontroller simulator. That's beyond the scope of this article, so we'll dodge the issue by returning a string with the names of all registers using that address. This will provide the end-user with some help without implying more than the disassembler is really capable of.

When we find an instruction that has a register as an argument, we do a quick lookup of the address against a list of register name strings. We return the string found and replace the hex value with it.

Many possibilities exist for the final output structure. I have chosen to emulate the Listing file produced by assemblers. This format shows addresses, hex values, code, and symbol table info all on the same page. A different output format could be designed which you could feed right back into an assembler. Readers can easily modify the output to meet their needs.

The easiest place to output the disassembled file is to the screen (or stdout.) This allows a quick view, or allows the output to be piped to a file directly. Using command line pipes and filters (such as '>' and 'more') saves a great deal of coding on an initial effort like this.

The Program Flow

1. Read the file.

Python looks for a section in the code (see Listing 1) that is testing for the __name__ variable (a special Python name for an internal variable) called '__main__' (line 273) and starts execution at that block. In our code, this section initially reads the file to be disassembled (lines 274-279) and sends it, line by line, to a subroutine called hexlineparser(line).

2. Create a data structure.

Function hexlineparser(line) uses a powerful Python mechanism to break the line from the hex file up into its constituent parts. Python allows substrings of strings (and its other sequence data types, lists, and tuples) to be accessed via 'slicing operators.' A slicing operator looks like: s[i:j] , which returns everything in s that has an index greater than or equal to i and less than j. Given the statements:

```
A = "howdy world"
C = A[0:6]
```

C is now equal to "howdy".

Once we have carved up the hex line into its parts using slicing operators, we have to take care of some conversion issues between ASCII and hex. When we read a hex value from a string such as '6A' we want the program to deal with this as a number, not two characters. To address this issue, we've created a function called hexish(tohex).

Function hexish(tohex) is passed the string we want to convert and returns the result of 'string.atoi("0x" + tohex,16)'. This call concatenates "0x" and the ASCII string passed to it (in our example, we would then have a string "0x6A".) "0x" is the prefix that Python uses to identify hexadecimal numbers. The command string.atoi then does a translation of ASCII to integer on the string we created using base 16. We now have an integer data type with the value of our hex number.

After all the pieces have been parsed out and we have trasmuted to hex the strings we need, we then proceed to populate a simple dictionary with the addresses and data values (lines 60-62). Line 61

```
ADDR  WORD  LABEL     OPERAND   ARG1,ARG2
0000  1683            BSF       STATUS,0x5       ;Restart Vector
0001  3000            MOVLW     0x0
0002  0086            MOVWF     PORTB/TRISB
0003  3000            MOVLW     0x0
0004  0085            MOVWF     PORTA/TRISA      ;Interrupt Vector
0005  1283            BCF       STATUS,0x5
0006  3000            MOVLW     0x0
0007  00AA            MOVWF     0x2a
0008  3010            MOVLW     0x10
0009  00AB            MOVWF     0x2b
000A  3002            MOVLW     0x2
000B  00AC            MOVWF     0x2c
000C  0AAA  TARG_1    INCF      0x2a,F
000D  1DAA            BTFSS     0x2a,0x3
000E  2811            GOTO      TARG_4
000F  01AA            CLRF      0x2a
0010  0AAA            INCF      0x2a,F
0011  082A  TARG_4:   MOVF      0x2a,W
0012  072B            ADDWF     0x2b,W
0013  0086            MOVWF     PORTB/TRISB
0014  3010            MOVLW     0x10
0015  07AB            ADDWF     x2b,F
0016  1FAB            BTFSS     0x2b,0x7
0017  281A            GOTO      TARG_3
0018  01AB            CLRF      0x2b
0019  00AB            MOVWF     0x2b
001A  082B  TARG_3:   MOVF      0x2b,W
001B  072A            ADDWF     0x2a,W
001C  0086            MOVWF     PORTB/TRISB
001D  0AAC            INCF      0x2c,F
001E  1DAC            BTFSS     0x2c,0x3
001F  2822            GOTO      TARG_2
0020  01AC            CLRF      0x2c
0021  0AAC            INCF      0x2c,F
0022  082C  TARG_2:   OVF       0x2c,W
0023  0085            MOVWF     PORTA/TRISA
0024  280C            GOTO      TARG_1
0025  0063            SLEEP

SYMBOL TABLE

ADDR  SYMBOL                0002  PCL
000C  TARG_1                0003  STATUS
0011  TARG_4                0004  FSR
001A  TARG_3                0005  PORTA/TRISA
0022  TARG_2                0006  PORTB/TRISB
0000  INDO                  0008  EEDATA/EECON1
0001  TMRO/RTCC/OPTION      0009  EEADR/EECON2
                            000A  PCLATH
                            000B  INTCON
```

Listing 3 — The output from the disassembler.

Listing 2a

```
STATUS   equ  03
PORTA    equ  05
PORTB    equ  06
TRISA    equ  05
TRISB    equ  06
RPO      equ  05

LED1REG  equ  02a
LED2REG  equ  02b
LED3REG  equ  02c

         wdtoff

         bsf     STATUS,RPO      ;init ports
         movlw   00
         movwf   TRISB
         movlw   00
         movwf   TRISA
         bcf     STATUS,RPO

         movlw   00              ;init led*reg
         movwf   LED1REG
         movlw   010
         movwf   LED2REG
         movlw   002
         movwf   LED3REG

loop     incf    LED1REG         ;inc led1reg
         btfss   LED1REG,3       ;skip next if >= 8
         goto    led1            ;jump
         clrf    LED1REG         ;clear led1reg
         incf    LED1REG         ;ledreg1 = 1
led1     movf    LED1REG,w       ;move led1reg to w
         addwf   LED2REG,w       ;combine with led2reg in w

         movwf   PORTB           ;output on portb

         movlw   010             ;setup w with increment
         addwf   LED2REG,f       ;inc led2reg (high nibbble)
         btfss   LED2REG,7       ;skip next if >= 8
         goto    led2            ;jump
         clrf    LED2REG         ;clear led2reg
         movwf   LED2REG         ;ledreg1 = 0x10
led2     movf    LED2REG,w       ;move led2reg to w
         addwf   LED1REG,w       ;combine with led1reg in w

         movwf   PORTB           ;output on portb

         incf    LED3REG         ;inc led3reg
         btfss   LED3REG,3       ;skip next if >= 8
         goto    led3            ;jump
         clrf    LED3REG         ;clear led3reg
         incf    LED3REG         ;led3reg = 1
led3     movf    LED3REG,w       ;moveled3reg t

         movwf   PORTA           ;output on porta

         goto    loop            ;do it all over again

         sleep

         END
```

Listing 2b

```
:1000000083160030860000308500831200 30AA007D
```

Listing 2 — An assembly language and hex output example.

sets up our loop using the built-in range function. Here we use range to start at 0, run for as many loops as the linelen (number of data bytes in the hex line), and count by twos. This allows us to process the line in words (two bytes), not single bytes.

In line 62, we chop out words from the set of data bytes and stuff them into our dictionary. We are still storing ASCII strings of the data at this point even though we translated some of the values we needed to determine the data byte count and addresses.

3. Perform the first pass.

We now proceed to our first pass of disassembly (lines 281-284.) The first thing we do is grab all of the addresses out of our dictionary using the .keys method and then use the .sort method to organize them sequentially. This allows us to retrieve the data bytes in the order that they are addressed. Python dictionaries do not maintain the entries in any sequence, so you have to manually declare a sequence or sort order if you want one.

The first pass of disassembly occurs in hexcodeparser_pass1(i) where i is the address of a data element in our initial dictionary. Right away we have to take care of some housekeeping and flip the data bytes. Intel Hex stores these values as least significant byte first and most significant byte second. We need to reverse this order. Line 67 takes care of this using our slicing operators.

Line 77 starts our sieve to find the instruction that this hex value represents. The first thing we do is verify that the address in question is within the code space of the PIC 16C84. Otherwise, we could crash our sieve by attempting to decode some data stashed in EEPROM that would be illegal as an instruction. We then start testing various bits from the hex value to see if they match groupings of instructions. Lines 104-111 demonstrate a good example.

In this example, we've determined that bits 12-13 are equal to zero (line 80) and that bits 8-11 are equal to or greater than 2. We then build a list of instructions that fall

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11974U........$4,257	66101A.........$592	8565E.....$44,070	CMD80....$17,965	5520A.....$10,432
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16518A.......$1,600	66103A.........$429	85719A........$689	FSEA20...$10,940	6062A.......$1,550
16522A.......$3,182	6612B...........$408	8590L........$3,540	FSEA30...$21,776	6080A.......$1,433
16533A.......$1,916	6621A........$1,069	8591C.......$6,198	FSEB20...$19,452	*ENI*
16557D........$5,535	6622A........$1,366	8591E.......$5,667	FSEB30...$29,732	240L............$894
1660CS........$4,074	6623A........$1,336	8593E.....$10,047	FSEK30...$39,453	5100L........$6,334
1662AS........$2,542	6624A........$1,792	8594E.......$7,228	FSEM20...$17,601	525LA........$2,340
16700A.......$4,231	6626A........$4,010	8595E.......$7,880	FSEM30...$25,649	550L..........$2,370
16702A.......$4,862	6629A........$2,603	8596E.......$9,141	SME03......$9,659	*Anritsu*
6717A.........$9,102	6632B...........$775	8643A.......$3,404	SME06....$15,612	MS4623B.$17,069
3245A.........$1,599	66332A.........$981	8644B......$11,655	SMIQ03B..$10,698	MS9710B.$18,516
33120A..........$843	6653A........$1,068	8645A.....$13,637	SMT03......$5,487	MT8801B.$13,825
34401A..........$487	6654A........$1,068	8648A.......$2,139	SMT06....$10,564	*Wiltron*
3458A.........$3,362	6673A........$1,788	8648B.......$3,518	SMY01......$1,914	67xxx..........$call
346A.............$664	6674A........$1,659	8648C.......$4,363	SMY02......$2,537	68xxx..........$call
346B.............$511	6683A........$2,396	8648D.......$4,896	**Check Out These**	
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37702A......$3,608	81103A......$2,430	8713C.......$5,623	11801B....$10,338	TDS794D...$22,207
37718A......$9,046	81106A.........$800	8714C.......$6,795	11801C....$11,223	TDS820.....$5,362
41421B.........$999	8110A........$3,162	8714ES...$13,329	1502C.......$2,428	TLA714......$5,584
41422A......$1,381	81110A......$3,541	8720D.....$31,990	370A.......$14,313	TLA7D1.....$3,504
41425A.........$587	8114A........$3,954	8720ES...$33,243	371A.......$16,135	TLA7D2.....$6,795
4142B........$3,784	8133A.....$21,733	8722D.....$45,912	AM503B.......$560	TLA7N3.....$4,994
4156A......$17,275	81530A......$1,681	8722ES...$43,823	AWG2021...$5,185	TLA7N4.....$8,116
4156B......$23,728	81531A......$1,214	87512A.....$1,088	AWG510....$7,305	TLS216......$8,635
41800A.........$439	8153A........$1,226	8753D.....$15,237	AWG520..$14,904	TSG130A...$1,127
4278A........$2,512	83050A......$8,665	8753E.....$16,922	AWG610..$17,147	VM700A.....$2,951
4284A........$4,622	83206A......$4,365	8753ES...$18,232	CSA803C..$7,462	VM700T.....$8,679
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54522A......$4,921	83752B....$11,854	E3633A........$657	TDS3032...$1,392	*TTC*
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6015A........$1,739	85025E.........$516	E4420B.....$3,439	TDS460A...$3,164	41440A......$1,107
6030A........$1,941	85027D......$2593	E4421A.....$4,571	TDS510A...$3,376	6000A.......$4,691
6031A........$1,688	85032B.........$812	E4421B.....$5,665	TDS520D...$4,016	6000FT......$4,057
6032A........$1,814	85033D......$1,272	E4422A.....$4,184	TDS540B...$3,168	FB500P......$4,027
6035A........$2,053	85052D......$1,667	E4422B.....$5,864	TDS540C...$5,592	TBERD1000.$3,131
60501B.........$604	8508A........$2,385	E4425B.....$8,220	TDS540D...$7,466	TBERD209A.$1,921
60502B.........$747	85107B....$54,767	E4432A.....$4,075	TDS640A...$2,610	TBER2090SP$2,711
60504B.........$906	8517B......$16,246	E4432B.....$8,661	TDS684B...$8,138	TBERD2209.$2,201
60507B......$1,101	8560E......$15,767	E4433B.....$9,528	TDS684C...$9,193	TBERD224..$2,498
6050A...........$901	8561E......$19,164	E7405A...$17,069	TDS694C$22,748	TBERD2310$10,551
6063B...........$848	8562A.......$9,199	E8285A...$32,424	TDS754D...$8,591	TBERD310..$5,109
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within this grouping (lines 105-107).

The value of bits 8-11 minus 2 provide the index which picks our target instruction from this list (line 108). We can then determine the second argument by looking at bit 7 and determining if it represents 'w' or 'f' (line 109). Since these instructions all have two arguments, we know that we will need a comma to separate them (line 110.) and finally, we use our list of registers to convert the first argument to a readable register name (line 111.). Once we've passed through this sieve, we populate our main data structure, 'asmlist', in line 145. If the address was outside the code space, the hex value alone is stored in asmlist.

4. Perform the second pass.

We now want to enhance our disassembly by labeling all our jumps and jump targets. We do this by executing hexcodeparser_pass2(). This function (lines 148-168) walks through the addresses in asmlist and looks for GOTO or CALL instructions (line 155.) When it finds one of these, it then converts the argument of this GOTO or CALL into a readable address (line 156) and looks up the details of that address from asmlist (line 157.)

If we haven't already discovered this target within some other instruction (line 158), we then increment our count of jump targets and make a note of it (lines 159-160.) We then proceed to give it a unique name based on the count and replace the jump target in the calling instruction. We also replace the label name in the target instruction with our unique name (lines 161-166.) We return the list of targets for use in printing the symbol table later.

5. Create the output.

The last major thing to do is output the disassembly (line 287.) We do this with the print_listing() function in lines 171-238. Each address in asmlist is handled in sequence and a structure of if-elseif statements (alas, Python does not have a 'case' statement, but this works exactly the same) determines the proper response.

The if statements serve to carve up the addresses into the different spaces such as code, code ID, config word, data etc., and prepares an appropriate header the first time one of these types is encountered.

Lines 214-217 add comments to lines that have a known function. Line 220 actually prints out the asmlist details using a formatted print statement. The formatted print statement requires a tuple, which is a list that cannot be internally modified. We create a list out of the address and the asmlist details for that address. We then use the tuple command to turn it into the format needed by the print statement.

Running the Program

Let's take our new tool for a spin. Using a simple PIC 16C84 program written in assembly (see Listing 2a) that sequences some LEDs on PIC port pins, we will feed its hex output (see Listing 2b) to our disassembler. The command line to print to a file would look something like

'c:\python PIC_dis.py test.asm > dis_test.txt'

depending on where the various files were installed. It is often convenient to run this without the '> dis_test.txt' redirector so that the output goes to the screen for quick debugging.

The output from the disassembler (see Listing 3) looks both similar and different from our original. The layout we have implemented in this version produces something that looks a lot more like the Listing output from an assembler than an .asm file. The code is certainly much more readable than the hex file was! We can determine the major registers in use, we can identify jump targets, and we can view a symbol table. This output is great for learning how problems have been solved in code, or as the basis for running code simulators or In-Circuit Emulators.

What Else Could You Do?

There are a number of exciting features that could be added to the disassembler. It would expand the usefulness of the tool to expand it out to assure compatibility with the entire set of PIC 14-bit instruction microcontrollers. Adding additional print formats to allow the output to be used directly by assemblers would be very handy. With a bit of work, a lot more comments could be added to the output, as well.

It would be an excellent exercise, for readers so-inclined, to turn the code for this article into a class for disassembling PIC 14 bit instructions, or even a generic OO disassembly class. Python also has a number of excellent parsing classes; it would be worth examining them as candidates for enhancement. The code for this article is in the public domain for anyone who would like to take it in that direction or make any other modifications desired. **NV**

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by Joseph J. Carr

Open Channel

Let's Be Radio/Electronics Safe ... Please?

Every now and then something happens to remind me that radio and electronics can be a dangerous hobby. Sometimes I read about some chap who is electrocuted erecting an antenna or working on a piece of equipment. In one case, I was present in a broadcasting station when an electrician working on the three-phase 440-VAC panel feeding the transmitter was electrocuted by working the panel "hot" and a wrench slipped and he became – shall we be crude – a 200-ampere "biological fuse."

In In another case, a friend of mine suffered serious injuries (arm, leg, and pelvis broken) because he failed to heed warnings about the difficulty of installing deep fringe area all-channel television antennas in a windy seashore location ... and was blown off a roof. Antennas – even television antennas – have a huge "sail area." That means they weigh more under even a slight breeze than they do under zero wind conditions.

Finally, a friend of mine was a professional electronics technician who worked on very large AM BCB and shortwave transmitters (50 KW) for the Voice of America in the 1950s and 1960s. The transmitters he worked on were not in cabinets but in metal "rooms." One day, he opened the access door and walked into the high voltage cage. Someone had disabled the interlocks that prevent accidents, so they could work on the live circuits. To his horror, he saw his companion about to throw the wall switch level that would energize the transmitter, unaware that my buddy was inside the cage.

Fortunately, he was armed with a large adjustable end wrench, which he threw with great force against the wall just above the switch panel. Startled, the rogue turned and noted with dismay that he damn near electrocuted his fellow worker. After that, only temporary interlock jumpers were permitted, and a padlock was placed on the power panel switch handle ... and the only key would be inside the cage with the worker in danger.

Antenna Erection Safety

Safety is not a "given" where antennas are concerned. Antennas are inherently dangerous to erect if certain precautions are not followed. It is not possible to foresee all of the situations that you might face in erecting an antenna. I would like to give you all possible warnings, but that is not even possible. You're on your own, and must take your own responsibility when installing an antenna. I can, however, give you some general safety guidelines. Knowledge of what you face, some hard-nosed sound judgment, modulated by common sense, are the best tools on any antenna job.

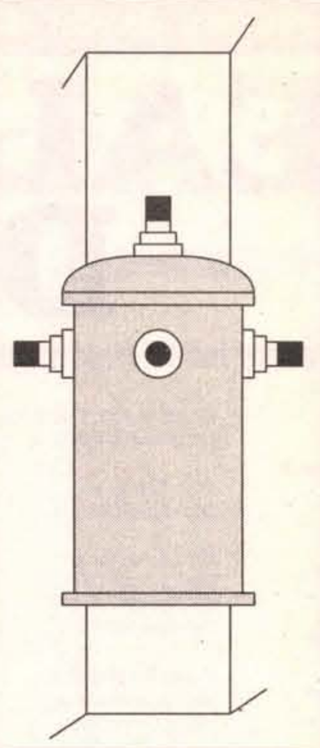

Figure 1
Dangerous power mains transformer.

One rule that is an absolute is that no antenna should ever be erected where either the antenna, the feedline, or any part thereof crosses over a power line or can fall into the power line ("pole pig") transformer (Figure 1). EVER! This is a "no kidder" – don't do it!

Power lines look insulated, but there are often small breaks or weakened spots (especially a couple days or more after original installation) that can bring the antenna into contact – lethal contact – with the hot power line. Every year or so, we hear about an SWL, scanner/monitor buff, or ham radio operator being killed by tossing an antenna wire over a power line. Avoid making yourself into a high power resistor!

And the same rule applies to situations where the antenna can fall onto a power line if it falls down or breaks. You have to examine the situation with a critical eye to see if there is any possible way for that antenna, or its support structure, to fall onto a power line if it breaks in any way whatsoever.

On my lot in Virginia, I have a 23-foot mast erected on the back of the house. When I installed it, I made a scale drawing of the back yard showing the path of the power line. The 23-foot fall radius of the antenna was plotted for several possible antenna locations. It should not intersect either the power lines or the cable TV line when it falls. It should also not be in a position to fall over a pedestrian path, a place where children play, or across a public walkway or street (lawsuits are messy). Or, as one chap found out the hard way, it should not be in a position to fall through a window!

Another caution is that you be physically fit to do the work. While the on-the-ground portion of the work is not usually too strenuous, any climbing at all, even on ladders, can be taxing for some people. Antenna materials are deceptively lightweight on the ground, but when you get up on even a small ladder, they are remarkably difficult to handle.

Attempting to manhandle a 22 foot vertical once wiped my back out, and I consider myself fortunate that the pain hit me after I'd dismounted the ladder. Besides, if you could see me, you would wonder why a man my size was on any ladder in the first place.

Before using a ladder, learn how to use a ladder. A lot of homeowners, whether putting up antennas or painting the upstairs windows, fall off ladders that were being used incorrectly.

If the wind blows even a few miles per hour, the danger is magnified considerably. The friend I mentioned previously – who is a large, strong bear of a man – attempted to install a 26-element television "all channel" antenna on the roof of his second story house. It is located on the Chesapeake Bay (at the point where the bay, Hampton Roads, and the Atlantic Ocean converge).

The antenna was easily handled with one hand on the ground and with no wind blowing, but up on the roof, it was a different story. He was on the peak of the roof, when a gust of wind came up suddenly and caught the antenna. It acted like a hang glider, and pulled

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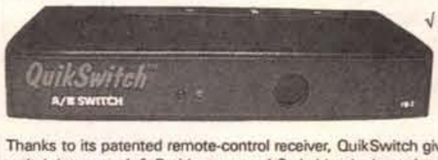

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him off the roof, plunging down two stories to the patio below; he fractured his pelvis and busted both a leg and an arm. Expensive TV antenna, I reckon. *Be careful!*

One good rule is to always work under the buddy system. Ask as many friends as are needed to safely do the job, and always have at least one assistant even when you think you can do it alone. Erecting a large antenna – and some small ones – without help is just plain stupid. At least have someone around who can call 911 if you mess up.

Always use quality materials and use good work practices. I generally prefer commercial kits, even for simple wire antenna. Antennas – being potentially dangerous – should always have the best of both goods and workmanship in order to keep quality high. Complex antennas have a lot of metal fittings and fasteners. Make sure that all are tightened properly. This is easy to overlook because some of those fasteners are usually left "finger tight" until the antenna tuning adjustments are made. It is not just the electrical or radio reception workings that are important, but also the ability to stay up in the air and safe.

When planning the antenna job, keep in mind that pedestrian traffic in your yard could possibly affect the antenna system. Wires are difficult to see, and if an antenna wire is low enough to intersect someone's body, then it is possible to cause very serious injury to passersby. In World War II, saboteurs and the Resistance – according to the movies – knocked Nazi motorcyclists off their bikes (and to their doom) using a bit of wire stretched across the road. Even when the person is a trespasser, the courts may hold you liable for injuries caused by an inappropriately designed and installed antenna. Take care for safety not only of yourself, but also of others.

One necessary reminder is that your local government might have some interesting ideas – legal requirements, actually – concerning your antenna installation. The electrical, mechanical, and zoning codes must be observed. There is a great deal of similarity between local codes because most of them are adaptations from certain national standards. But there are enough differences that one needs to consult local authorities. Indeed, you may need a license or building permit to install the antenna in the first place.

One problem that SWLs and scanner monitors in the USA face is that their antennas are not protected by the FCC as are ham antennas. Local governments in the USA have limited rights to regulate ham antennas, only "reasonable" mechanical and electrical standards can be imposed, so it may be illegal to install any antenna.

About 30 years ago, a friend of mine in a radio club found out that his county had an ordinance that said an outdoor antenna must be double its own height plus 50 feet from the nearest property line. He received a summons after a complaint from a neighbor. In a county full of quarter acre home lots, however, that was a ridiculous law. Very few outdoor TV antennas met that strict requirement!

So Hal went to the court house and asked for 50,000 complaint forms. Using a local county directory, he proceeded to fill out the same complaint as he'd received against every homeowner in the area. The county board repealed the law during the next meeting.

Save all paperwork regarding your building permit, including inspection decals or papers, and the original drawings (with the local building inspector's stamps). If a casualty occurs, then your insurance company may elect to not pay off if you have violated an electrical, mechanical, building, or zoning code. That clause may be overlooked by an enthusiastic antenna builder, but it could prove to be a costly oversight if something happens.

Tower Safety

Still another friend of mine – a chap I worked with in the 1960s – is a professional tower and antenna rigger. His main work is broadcast and commercial towers, but he also does some 100-foot amateur radio towers as well. He is normally quite a conservative fellow when working (except for the time in his youth when he dropped his trousers and defecated from the 1,020-foot level of a local TV tower!), and had some tips to pass along.

First, don't even think about working a tower without using an approved safety belt ... and inspect it before each use to make sure it is in good repair. My friend uses two safety belts. One is the standard type, and the other is one designed to simply hitch him to the tower, and is used as a backup in case the regular one fails.

Second, wear an approved motorcycle crash helmet. It's amazing how many things fall off antennas and can hit workers below in the head.

Third, tether tools with strong twine or small rope. If you drop a tool, the guy below you will need the crash helmet.

Fourth, don't work when tired, or when it is either too hot or too cold for reasonable comfort. It is better to come back another day than to make the kind of mistakes that fatigue produces.

Fifth, wear appropriate comfortable clothing (including shoes or boots).

Finally, if you work on a slip-up tower, then use a safety bar (Figure 2) to prevent the inner section(s) from slipping down while you are on the tower. The safety bar is a hardened steel bar, and is held in place with light but strong chain. It prevents "guillotine" action that severs hands and feet.

After hearing about one situation, I would also suggest keeping one person on the ground as a safety observer. A fellow I read about had a minor heart attack while up on a tower. Use a handheld radio to keep in contact. If remote, equip the ground observer with a cellular telephone to call for help in case you are injured or become ill.

I was tempted to call this section "having a safe erection," but something told me it wasn't appropriate.

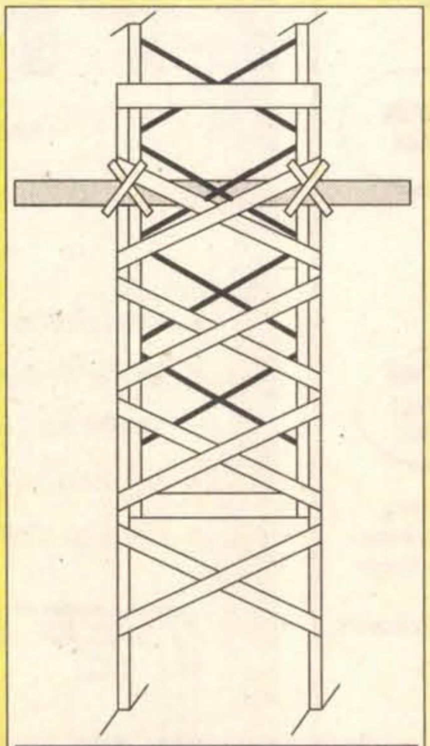

Figure 2
Safety bar on slip-up tower.

Hearing Safety

Another safety issue regards your ears, or more specifically your hearing. It is a bit less dramatic than electrocution or falling off roofs, but it is nonetheless quite important. I never have a quiet day. Why? Because my right ear has a constant, never-ending ringing that sounds about like a 4 KHz

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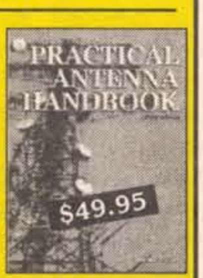

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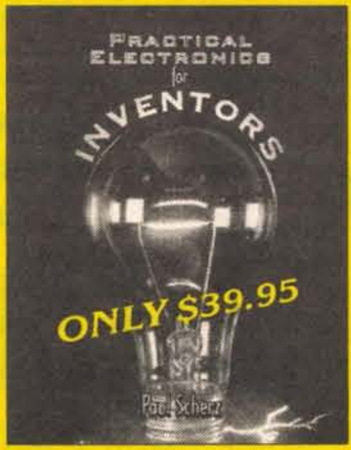

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Let's Be Radio/Electronics Safe ...

sinewave. The ringing started about two years ago. It wasn't constant at first, but over several weeks it got real darn annoying. So I went to the doctor who, in turn, referred me to an ENT ("ear, nose, and throat," aka "Otolaryngologist" when he wants to impress himself or charge more money) doctor.

The ENT doc sent me to an audiologist who ran a simple audiogram and found rather bad high frequency hearing loss in that ear. She next ran an evoked potentials test called an "ABR." In this test, they measure the patients EEG (brain waves), while repetitively providing the same tone to each ear in turn for several minutes. When the EEG waves are signal averaged, the component due to the sound emerges and the rest is filtered out. It was abnormal.

The ENT doc next sent me to have a magnetic resonance imaging (MRI) scan of the brain to rule out an acoustic neuroma tumor. Now that's an experience! It doesn't hurt, but MRIs are aggravating as all get out. The test came back normal. The ENT doc told me "I've got good news and bad news. The good news is that you don't have a tumor." So I asked him about the bad news: "... you don't have a tumor. If there was a tumor, then there's something I could do for you. Without the tumor, you'll just have to live with it."

We discussed my audio history. In many people my age, the cause of ear ringing is 1960s vintage rock music, which we heard live. But that was not the case because I have disdained post-1960 (or so) rock music for many, many years and have never voluntarily listened to it for more than a few milliseconds (I'm a bluegrass and 50s rock fan). And I never listened to it loud. After further questioning, the doctor believes that my problem is due to my shortwave listening and ham radio hobby.

Yep! Radio! The problem stems from the late 1950s and early 1960s when I was operating every day for several hours instead of doing homework (which explains my high school record!). With the gain up high, listening for a weak signal through earphones, I would frequently tune across some guy who was about a gozillion decibels stronger than signal I was copying. Either that, or the clown across town running a 2,000-watt loudenboomer RF power amplifier into a high gain bandbuster antenna settled right on my frequency without listening first (rude!). I can remember some of those events causing an (almost pleasurable) buzz in my right ear. Those experiences caused damage to the cochlea structure of my inner ear.

I normally don't like to share personal things with my readers, but this story is a "lessons learned" tale that hopefully prevents you from having similar problems. Earphones put a high audio power density into your ear. Even though communications receiver audio output stages tend to be low power (<1 watt in many cases), the power density is high because of the confined area provided by earphones. The high power density makes 40-meters CW like being too close to the bandstand at a rock concert. Avoid using the earphones in a manner that assaults your ears!

I asked the ENT doc how this problem could be prevented. His advice was three-fold:

1. Wear "shooter's earplugs" under the earphones. These ear plugs are used by target shooters to prevent ear damage. They have a little piston plunger inside. The plunger stays open at normal sound levels, so you can hear what's going on around you, but snap shut when a high amplitude sound (like a pistol shot or loudenboomer signal) is received.

2. Wear the earphones a little forward of the ears, so that the ear is not fully covered.

3. Ride the volume control so you can instantly knock down the signal level if it gets louder suddenly.

That second piece of advice struck me hard. It was one of those "slap-palm-of-hand-on-forehead" experiences. My ham radio mentor, the late Mac Parker (W4II), told me exactly the same thing when I was 14 years old. In addition, a number of professional merchant marine radiotelegraphy operators, and a former boss (who was a Chief Radioman in the World War II US Navy) gave me the same advice. But, dumb kid, I didn't follow it.

When I left the ENT doc's office, I asked him: "If you can't get rid of the ringing, will you at least tune it to the bluegrass station?" **NV**

Connections ...
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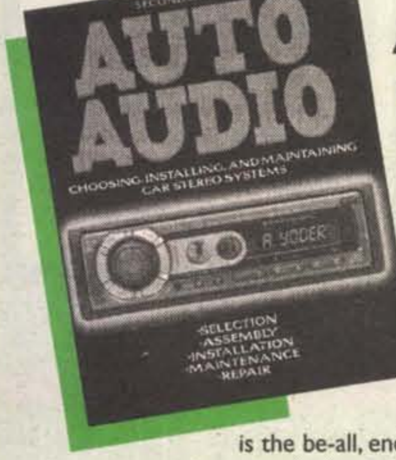

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One of the bestselling car stereo books ever, this is the be-all, end-all guide to maintaining a complete automobile audio system. Whether you're a serious audiophile or tinkerer, and whether your dream is a boombox on wheels, or just a serviceable car stereo system that sounds good, this book has all the answers. In this fully illustrated, break-it-down-to-basics guide, one of America's most popular consumer electronics writers shows you how to:

- Save hundreds of dollars on car and truck audio equipment selection, purchase, installation, upgrade, maintenance, and repair
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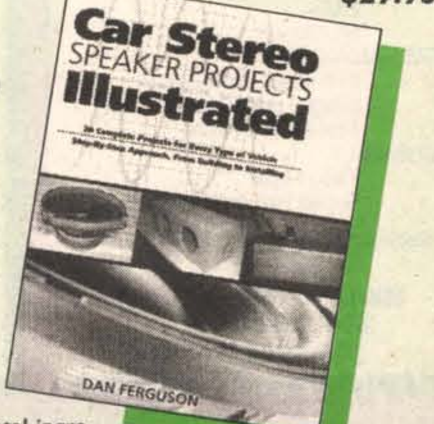

Want to almost phone in ultimate, high-end, custom auto speakers? Talk about simple — this heavily illustrated, step-by-step guide puts leading-edge auto speakers within anyone's grasp. Speakers are, of course, the pivotal ingredient in any sound system, and this book makes it possible for you to create the ultimate custom sound to enhance your ride. Written by Dan Ferguson, the author of two previous books and many articles on speaker-building, this clear, complete guide removes the confusion from building your own auto speakers, while adding more fun. This book helps you:

- Plan the ultimate speaker system for your particular vehicle
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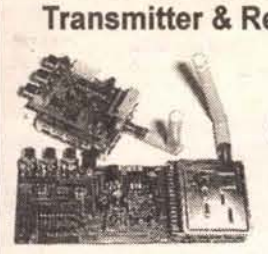

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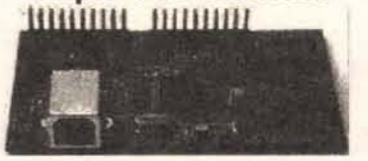

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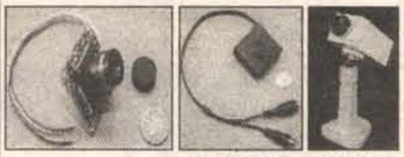

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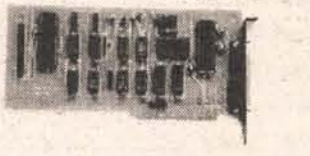

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All classified ads are running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in *Nuts & Volts* is limited to **electronically related items ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the 60¢ rate only through their subscription expiration date. **NO REFUNDS**. Credit only. No credit for typesetting errors will be issued unless you *clearly* print or type your ad copy.

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Product/Category INDEX

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Newsbytes continued from page 19

control that is very easy to use. An optional steering wheel mounted remote control is available to operate both the navigation system and a Blaupunkt car audio system.

Blaupunkt's TravelPilot technology has been proven in over 300,000 car navigation systems already sold by Blaupunkt and under license by several of the world's most respected auto makers.

The new DX-N is both flexible and expandable. With optional interface modules, it can be connected to on-board VCRs, DVD players, and video games. Additional video displays can also be mounted for viewing maps or video by rear seat passengers. [The ultimate accessory for the back seat driver.]

Like all TravelPilot systems, the DX-N uses a clear, pleasant-sounding voice to provide precise turn-by-turn directions to the driver over the car audio system. The video display supplements the voice guidance system by displaying directional symbols, a moving-map display, and additional information like estimated time of arrival, and distance to next turn. It is also used to display set-up and system functions.

Destinations can be entered for a town center, street address, or intersection, or selected from a large list of points of interest, such as gas stations, restaurants, airports, hospitals, parks, theaters, shopping centers, etc. In addition to programming a single destination, the driver can program "tours" of multiple destinations — perfect for a salesperson. When faced with traffic or road work, the driver can press the "congestion" button, and the DX-N will suggest an alternate route.

The Blaupunkt TravelPilot DX-N uses an advanced 32-bit RISC processor for fast access speeds, rapid route calculation, and outstanding graphics display. Its navigation resources include an integrated eight-channel GPS receiver, directional gyroscope, and speed sensor input. With map matching plus the speed and gyro inputs, the system is accurate to within 15 feet. It allows the DX-N TravelPilot system to continue navigating when GPS satellites are blocked by buildings, terrain, or trees, and to negotiate closely spaced turns without getting confused.

The route guidance software considers the type of road and probable speeds in planning a route. The driver can chose the fastest or the shortest route, and select a stopover point. The driver can also effect the route selection by noting known blockages. Points of interest can be selected by name, by category, or by distance from either the current location or from the current destination. For example: 'find the nearest restaurant,' or 'find a restaurant near the destination.'

The Blaupunkt TravelPilot DX-N has a suggested retail price of $1,999.00. Maps and travel data for the entire US are provided on nine regional CD-ROMs which cost $229.95 each.

About Blaupunkt

Blaupunkt, the mobile electronics division of The Robert Bosch Corporation, designs and manufactures high-quality and high-performance car audio and navigation products for sale worldwide. For Blaupunkt dealer locations and product information, call **1(800) 950-BLAU** [2528] or visit the company's web site at **www.blaupunkt.com**.

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Print Visual Basic Source in Color and Export it to Word Processors

Jn-Software has released VBcodePrint v. 6.13, a Microsoft Visual Basic add-in that saves system development and maintenance time and money by enhancing source code printing. VBcodePrint's main window is a dockable floating toolbar that integrates fully with Visual Basic, and can be used to set options, preview source code, print it without previewing, export the formatted output to Rich Test Format (RTF) ready to be incorporated into word processors, or view the help file.

VBcodePrint's color-coded printing lets users specify the font attributes and colors for comments, identifiers, keywords, line numbers, strings, procedure headings, and page headers and footers. This color coding, combined with source code indenting and line numbering, make it quicker and easier for software developers to write and maintain Visual Basic programs.

Using an Explorer-like selection control, you can print any combination of procedures, components, and projects. These selections can be saved and restored for later printing. The program's WYSIWYG preview screens let you look at the formatted source code with unlimited zooming, multi-page thumbnails, and side-by-side page previews.

Users have total control over page layout, including paper source, orientation, borders, margins, headers, and footers. You can even print in multiple columns. Line spacing can be set to .5, single, 1.5, or double-spacing. With the proper printer drivers, the output can be scaled, and print quality can be adjusted from draft through high quality.

Contract programmers can reduce clients' maintenance costs by using these more informative printouts, and they can reduce clients' down-time by being more speedy when responding to service calls. Companies with in-house programming staffs can save training time because the easy-to-read printouts make it easier to get a new maintenance programmer up to speed. Cross-training becomes simpler and less costly, and communications between programmers and system analysts are facilitated.

VBcodePrint requires Visual Basic 6, costs $25.00 (US), and may be purchased securely online at www.jn-software.com. Earlier versions of VBcodePrint, supporting earlier versions of Visual Basic, are available. VBcodePrint and SQLPrint may be purchased together for $39.00 (US). You can download a fully-functional, 30-day trial version of either program from the same web site. For more information, contact

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Phone: **+44 118 9780421**
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E-mail: **jnahil@jn-software.com**
Internet: **www.jn-software.com**

Links to sample screen shots, as well as a preview of the VBcodePrint output, are located on
www.jn-software.com/

About Jn-Software

UK-based Jn-Software specializes in marketing development tools that increase the productivity of Microsoft Visual Basic and SQL Server developers. In addition to VBcodePrint, Jn-Software offers SQLPrint, a Windows development tool that makes it easy to produce professional looking documents for Microsoft SQL Server dictionary objects. Later this year, Jn-Software will release VBAPrint, a program that offers the same functionality as VBcodePrint for programmers who develop applications using VBA in Microsoft Office2000.

reader FeedBack Continued from page 19

specified.

The amplifier in Figure 3b is very interesting. The Darlington input stage has a reasonable current (10mA) through Q2, and the emitter follower configuration has negative feedback to reduce distortion. The second stage (Q3), however, is a disaster. First, its bias current is one-tenth that of Q2 and there is no negative feedback, so Q3 will distort signal levels that are faithfully reproduced in Q2. Q3's bias current should be at least Q2's. Second, the stage has no power gain. Its voltage gain, when driving a 50 ohm receiver, is only 2. The reactance of C10 at 160kHz is 10 kilohms; the input impedance of Q3 is about 2.5 kilohms. Thus the input coupling attenuates the input voltage by a factor between 4 and 5, and the whole second stage looks like a voltage attenuator. When impedance levels are considered, the story is much worse. The impedance mismatch between the first stage (whose output is a few ohms) and the input to the second stage (10 kilohms) produces an additional 30dB mismatch loss.

The second (500kHz) broadcast band filter is not very effective for low BCB stations. A seventh order 0.1dB Chebyshev filter has about 40dB of attenuation at 1.5 times the band-edge frequency (if the bandedge is specified at 0.1dB). The first (300kHz) filter will provide at least 40dB of attentuation for all frequencies above 450kHz, but the second filter has less than 20dB of attenuation at 540kHz. Most interference filters use zeros to get good close-in supression. The column also switches millihenries and microhenries in some places, and the Toko part numbers are actually Digi-Key's catalog numbers for the Toko parts. The filter values depend not only on bandedge frequency, but also on the impedance level, which was not specified. The impedance level must be matched at both the filter input and the filter output; any mismatch alters the resonator Q (as in the signal generator example above) and affects the filter's performance. Even if the impedances match, some filters cannot be cascaded.

On another note, Carr's band definitions are loose. The band definitions have precise decade ranges: LF is 30kHz to 300kHz, MF is 300kHz to 3MHz, and HF is 3MHz to 30MHz. In fact, there is a whole series of systematically named decade bands that goes from ELF (3Hz to 30Hz), SLF, ULF, VLF, LF, MF, HF, VHF, UHF, SHF, to EHF. I think these definitions were set in a 1959

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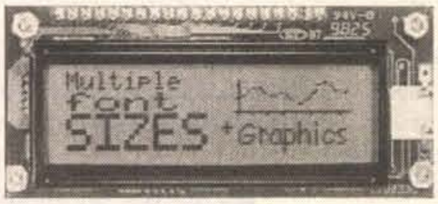

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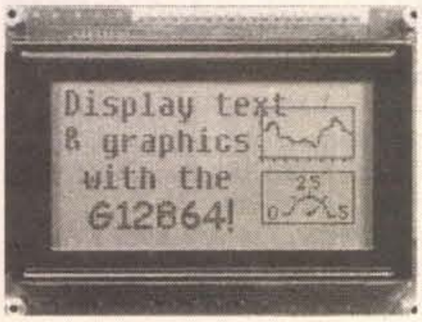

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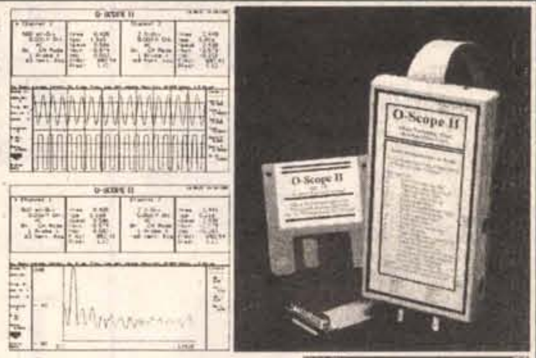

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Geneva radio convention. Modern usage tends to refer to the top of the UHF band and above by microwave band designations (such as L, C, and K). Practical usage also merges the bottom bands. A VLF receiver should cover at least something in the 3kHz to 30kHz band, but lower frequency receivers are usually referred to as ELF-VLF receivers. The moniker may be short for the range ELF-SLF-ULF-VLF, or it may reflect the limited utility of the SLF and ULF bands — too much power line noise, too difficult to radiate, and too little bandwidth. The military likes the ELF band (which is below the power line frequencies) because it reaches submerged submarines, and the military can justify huge transmitting antennas and small bandwidths in the interests of national defense.

In spite of the above comments, I enjoyed both articles. The design issues are subtle, and many commercial products have similar flaws. None of these problems prevent the designs from working, but they do impact the design's performance or its reproducibility.

Gerald Roylance
Mountain View, CA

Ir"resistor"ble Program at Electronix Express Web Site

Dear Nuts & Volts:

As a subscriber to Nuts & Volts, I wanted to pass along something really helpful I found at the web site of one of your advertisers.

Electronix Express has a Tech Tips section, and in there I found a nifty little program for picking 1% resistors to set the gain in op-amp circuits. It may not sound like much, but if you've ever tried finding the best pair of 1% resistors by trial and error, you'll appreciate how useful it is.

You can download the program from:
http://www.elexp.com/t_find_r.htm

Jim Stewart

Point of Patent-Pending Pedaler is Powering Picture

Dear Nuts & Volts:

Thank you very much for presenting our new product, the patent-pending Pedaler exercise system, in your Aug. 2000 issue.

It seems, however, that the major concept was missed in the text. That is, with the TV Pedaler, you have to keep pedaling or the TV screen gets scrambled.

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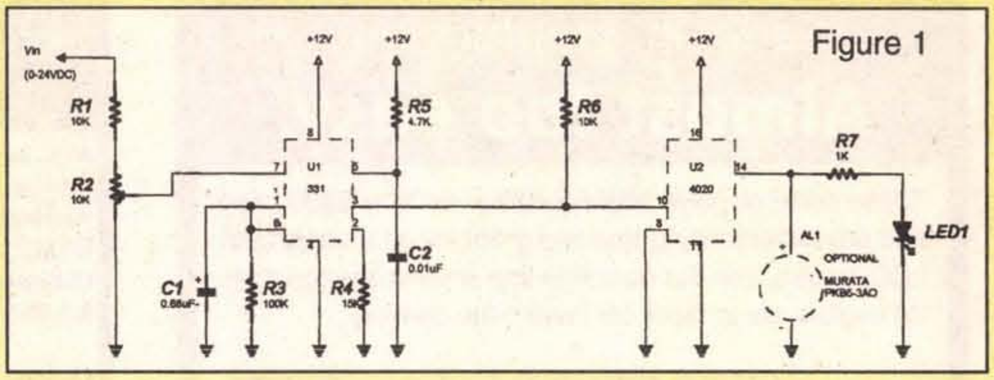
VOLTAGE-CONTROLLED FLASHER

by Dennis Eichenberg



There are certainly abundant analog and digital voltmeters available to provide accurate voltage measurements. But oftentimes, a very simple visual voltage indicator is all that is required. The voltage-controlled flasher shown in Figure 1 performs this task admirably. The LED is off when the input voltage is 0 volts and flashes progressively faster as the input voltage is raised until the LED is on continuously. A quick glance to the LED will indicate the relative voltage level.

The heart of the circuit is the 331 voltage-to-frequency converter U1. It is very linear, extremely stable, operates on a single supply, is very efficient, and inexpensive. The output frequency of U1 is Vpin7/2.09 x R4/R3 x 1/R5C2. A voltage divider comprised of R1 and R2 is used to scale the input voltage as desired for U1. R2 can be adjusted to precisely provide the desired flash rate. The output of U1 is divided by the 4020 binary ripple counter U2. A division of 2^{10} was found to be appropriate for this application. The output of U2 drives LED1 via current limiting resistor R7.

A Murata PKB5-3A0 piezo-electric alarm AL1 can be connected to the output of U2 as shown if an audible indication of voltage level is desired. **NV**

VOLTAGE-CONTROLLED FLASHER PARTS LIST

No.	Description
U1	Voltage-to-Frequency Converter, 331
U2	Binary Ripple Counter, CMOS, 4020
LED1	LED, Red, RadioShack No. 276-041
R1,6	Resistor, 10K 1/4 watt
R2	Potentiometer, 10K, 1/4 watt
R3	Resistor, 100K, 1/4 watt
R4	Resistor, 15K, 1/4 watt
R5	Resistor, 4.7K, 1/4 watt
R7	Resistor, 1K, 1/4 watt
C1	Capacitor, 0.68 uF, 25 WVDC
C2	Capacitor, 0.01 uF, 25 WVDC

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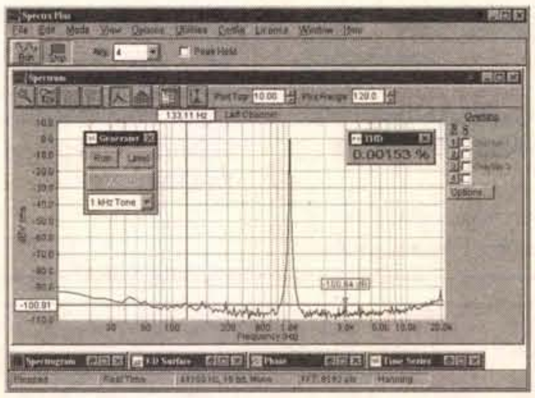

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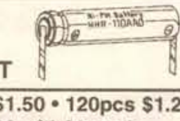

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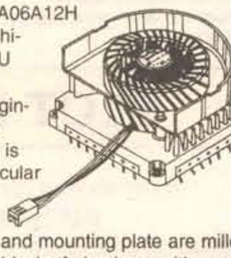

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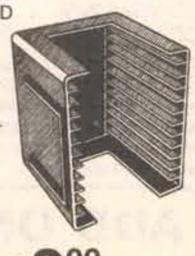

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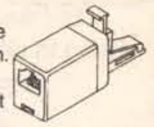

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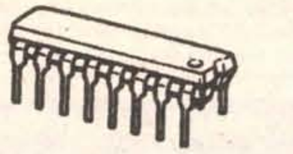

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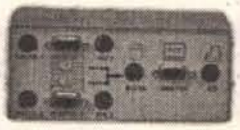

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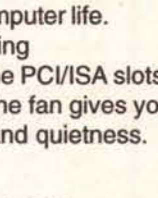

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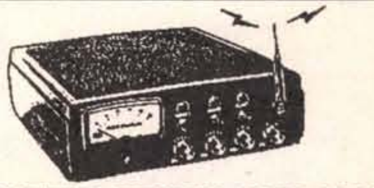

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AMATEUR ROBOTICS NOTEBOOK

by Robert Nansel

Planes, Trucks, and Ferries

My journey to this year's GEAR began further from Seattle than that of anyone else, all the way from Pittsburgh, PA. Shoshana, Yonatan, and I first flew to Bozeman, MT so my folks could get their twice-yearly fix of their grandson. We spent a pleasant week in their log home on the Jefferson river just outside of Three Forks, and gathered our strength for the marathon of driving to come. Aside from our normal luggage and baby support paraphenalia, I had brought with me on the plane Jiffy, a camp stove, a mug, a lantern, and a laptop computer — just part of the bare minimum to survive camping at GEAR. I borrowed the rest (tent, sleeping bag, ice chest, and a pickup truck to haul everything) from various family members.

The trip from Three Forks to Seattle is an easy 11 hours, but I had never driven it with an 18-month-old baby and a pregnant wife, and we weren't driving directly to Seattle, anyway. I wanted to swing southwest to Portland first to see Marvin and Coreen Green. Marvin is a good friend, a gifted amateur robot builder, and an old GEAR stalwart, but his anniversary vacation plans wouldn't allow him to attend this year.

I've also got relatives near Portland who haven't met my son and wife, plus a couple of writer friends I would like to catch up with. And I could go to Powell's Technical bookstore, too. Any one of these was good enough reason to drive to Portland. A no-brainer.

More like brainless.

It was a 14-hour drive with just two rest stops between Coeur d'Alene, ID, and Portland. The three of us were crammed in the front of the pickup, and the person driving could shift gears only if the passenger held Yonatan's legs out of the way. (Yonatan liked to amuse himself by kicking the gearshift, which was okay when cruising, but potentially disasterous when driving in town.)

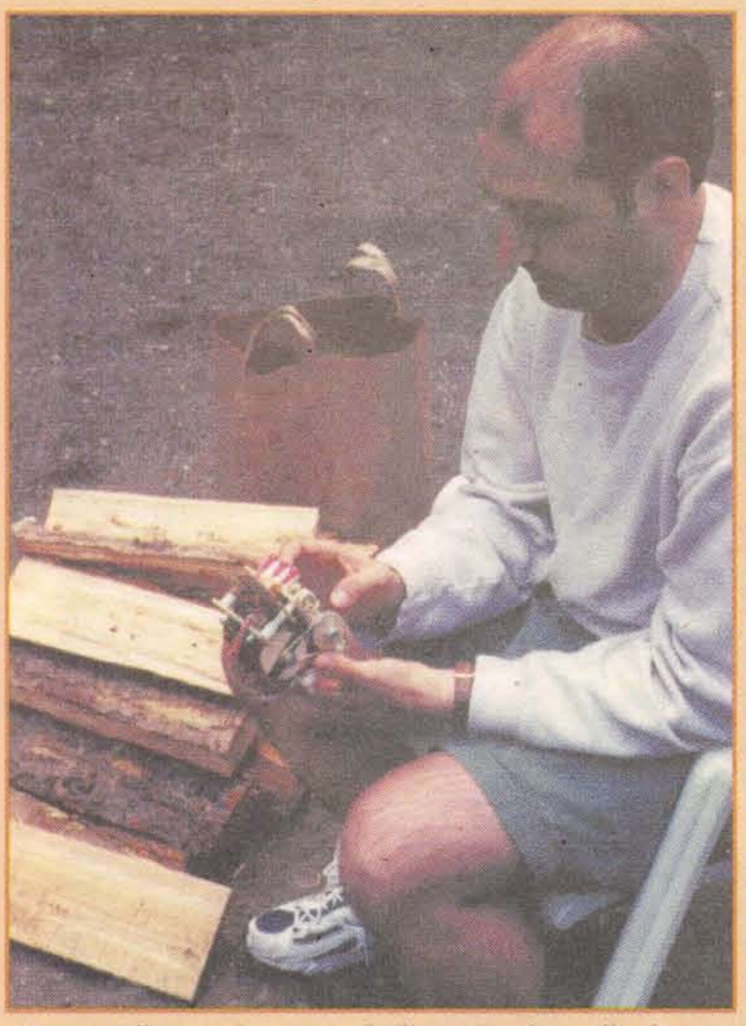
Murphy Strikes

It is a well-observed thermodynamic phenomenon that the entropy (some say perversity) of the universe tends toward a maximum, at least in the parts I visit, so I should not have been surprised that both entropy and perversity stalked us the whole trip. When I arrived in Portland, I called Marvin's number only to discover from Coreen that he'd been called away at the last minute on an emergency to Minneapolis to nurse an ailing web server.

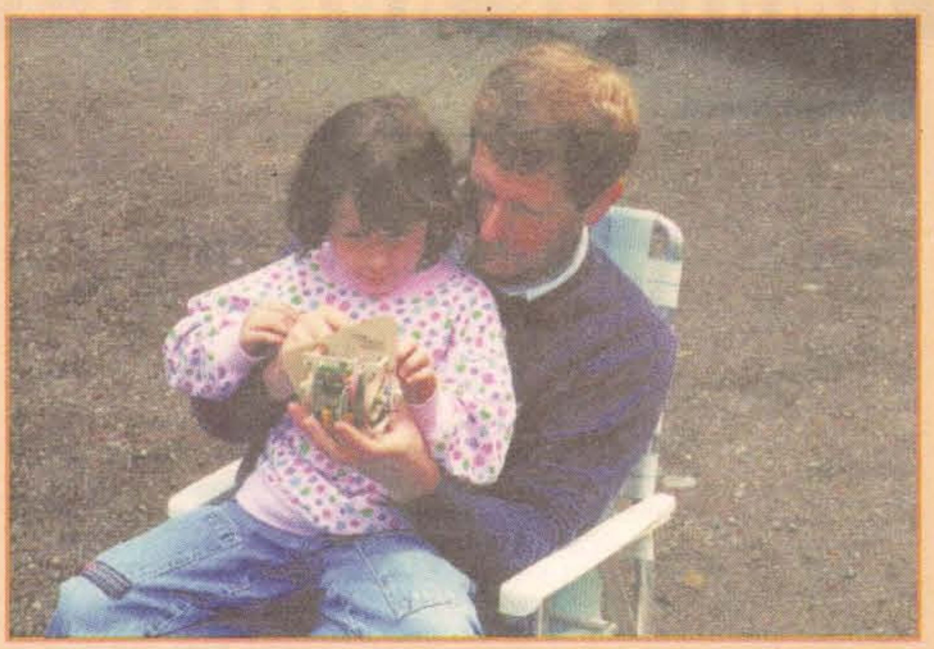
Bill Harrison of Sine Robotics brought this Hexapod II (Professional Edition), a sharp looking kit with excellent performance from Lynxmotion (www.lynxmotion.com).

We had a short visit with Coreen, saw everyone else we intended, and paid our respects to the Pacific Ocean and Powell's.

The Seattle segment of the trip started well enough, if a little frenetic: Thursday afternoon stop at REI to get more camping supplies, zip over to Jam Juree to eat Thai food with more writer friends, head north to



Doug Kelly examines one of Bill Harrison's small robots. This 'bot is made mostly from hobby shop plywood. It uses rubber bands and plywood pulleys for speed reduction.



Jeff Bronk and his daughter Anna look over Bill's robot. This view shows the triangular bumper used for wall following.

Echo Lake to stay the night with one of those friends, swoop back downtown for a mid-morning meeting the next day, back north at noon to buy food for GEAR, then get lost in Seattle traffic on the way to the Mukilteo ferry. Somewhere in all this it began to rain, though it was supposed to clear up by Friday evening.

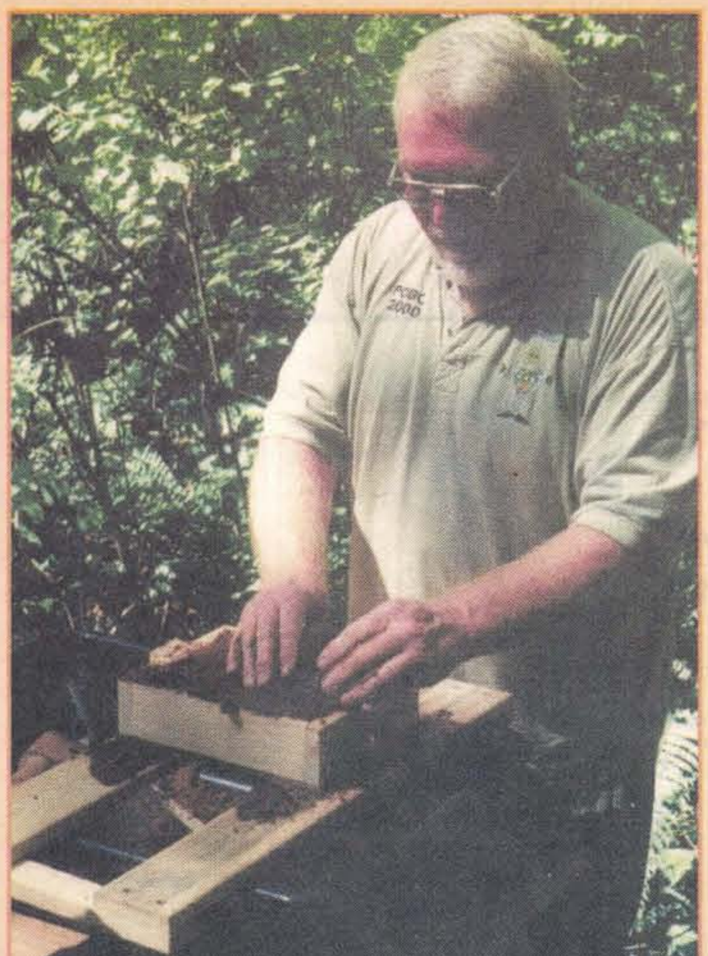
We had to wait an hour and a half to catch the ferry, so it was after dinner by the time we got to South Whidbey Island. Bill Harrison of Sine Robotics had arrived the day before, and the rest of the campers arrived that afternoon. I was the last one to show. I unpacked the truck and set up camp while Shoshana kept Yonatan from finding too many mud puddles. Since Shoshana was four months pregnant, and Yonatan was adept at finding mud and as exuberant about it as a puppy (with about as much common sense), we had decided ahead of time that Shoshana and the boy would not be camping — not this year, at least. They were to head back to Seattle to stay with a friend of hers.

An important note for next year: Be sure to check that the tent I borrow has its rain fly and stakes; I got all the way to South Whidbey Island before I discovered these things were missing. The stakes I could live without (there was barely a breeze), but I looked up at the clearing sky, pondered the probabilities, and borrowed a tarp to pinch hit as a rain fly. Thus weather-proofed, I waved as Shoshana and Yonatan drove away.

High GEAR

Aside from Bill Harrison and his wife and two daughters, that first night we had as fellow GEAR campers Ron Nucci and his wife Nancy and their son Peter, Jeff Bronk and his daughter Anna, Doug Kelly (from whom I borrowed the tarp), and Gene Elliot and his wife Val.

Bill brought a trailer and Gene came in a Winnebago. The two of



Gene Elliot is ramming up the drag half of a sand mold, the first step in the process of casting aluminum — right in the camp ground! He's using Petrobond, an oil-based casting sand that's much easier to use than ordinary "green" (moist) sand.

Here Gene is striking off excess sand from the drag. The pattern being molded is a medallion made especially for GEAR The resulting casting will be awarded to the best robot built during the campout.

Bill Harrison and his daughter Isa demonstrating a no-solder servo modification.

Preparing the cope half of the mold. The sprue hole has been cut, and Gene is cleaning up the pour hole on the opposite side. Note the white parting powder on the drag. The clay pattern has already been removed.

them spent most of that first night at the picnic table talking about the funny-looking jeep Bill uses to tow his trailer. It was an antique called a "Willy," though this particular one was special because it was a two-wheel drive rather than the more common four-wheel-drive (and, thus, impossible to get parts for).

The rest of us were gathered around the campfire trying to get our minds into camping mode, but most of us were still mentally at work and spoke of IPOs, stock options, difficult co-workers, and software development management. (This last sounded like an oxymoron to me since I hear managing programmers is like herding cats; maybe it should be called software development survival.)

That first night, GEAR seemed different to me. First of all, it was going to be shorter — we were starting on Friday rather than Thursday. In the Seattle Robotics Society, the purpose of GEAR had always been to tear us away from our quotidian world of jobs, telephones, and computers, to let us connect in ways we could not during the brief SRS meetings on the third Saturday of every month. I was newsletter editor for the SRS in the early 90s, when the SRS was growing rapidly. I always had a bunch of announcements to make at meetings, and after the meetings, when I really wanted to talk more in depth with folks who'd presented some cool ideas or gadgets, I'd be besieged with other people wanting more information or to give me their membership dues.

GEAR was supposed to give us time to relax and just be Human Beings instead of Human Doings, to loosen our creativity. This time, aside from the talk of work, there were cellular telephones and laptops at GEAR. I worried we might never get to a relaxed state of creativity in just two nights, and the phones and laptops only increased my apprehension.

If you have suggestions, questions, or comments about amateur robotics topics or, if you want to come to High GEAR, you can reach me at:

Robert Nansel
Box 228
Ambridge, PA 15003

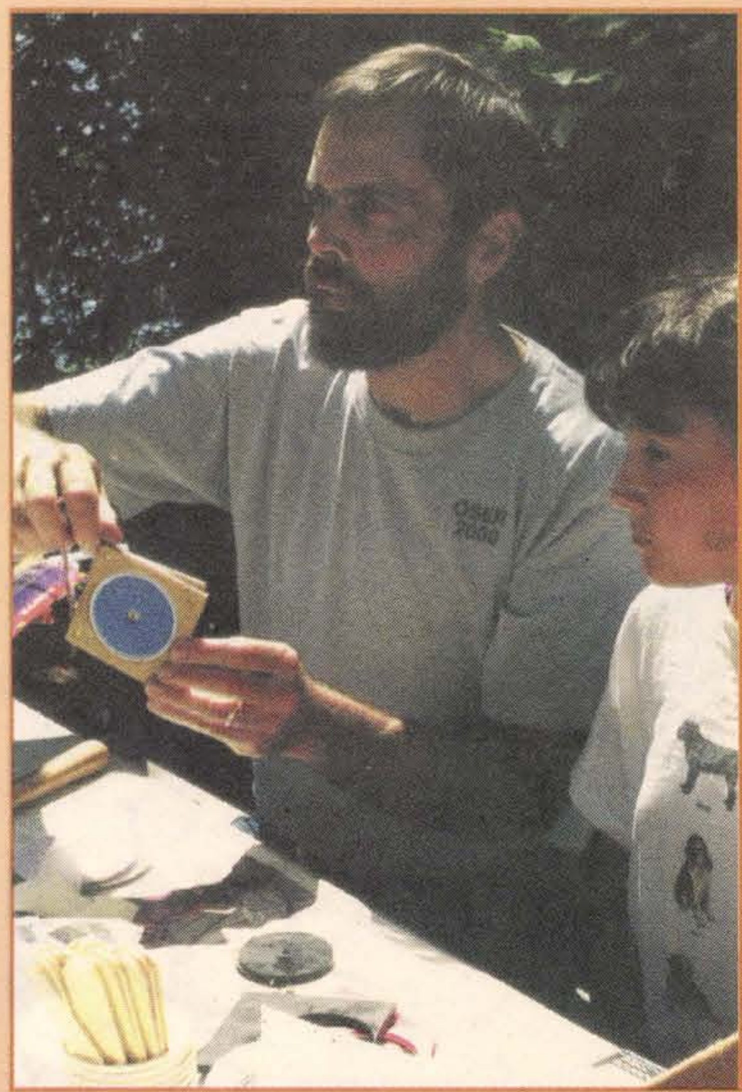
E-Mail:
bnansel@nauticom.net

Are We Relaxed Yet?

As the sky darkens, we slip into the right groove. Jeff Bronk begins to talk about the '332 SIG of the SRS. Jeff is a member of the quadrumvirate that has labored for more than a year to produce hobbyist-friendly 68332 boards. I will be reviewing these boards in depth in this column in coming months, but let me just say now that I'm really excited about the work of the '332 SIG. Their professed goal is to make available boards with the power and flexibility of a 32-bit processor, but with the simplicity and low cost of an eight-bit processor. Marvin Green's BotBoard II is their inspiration.

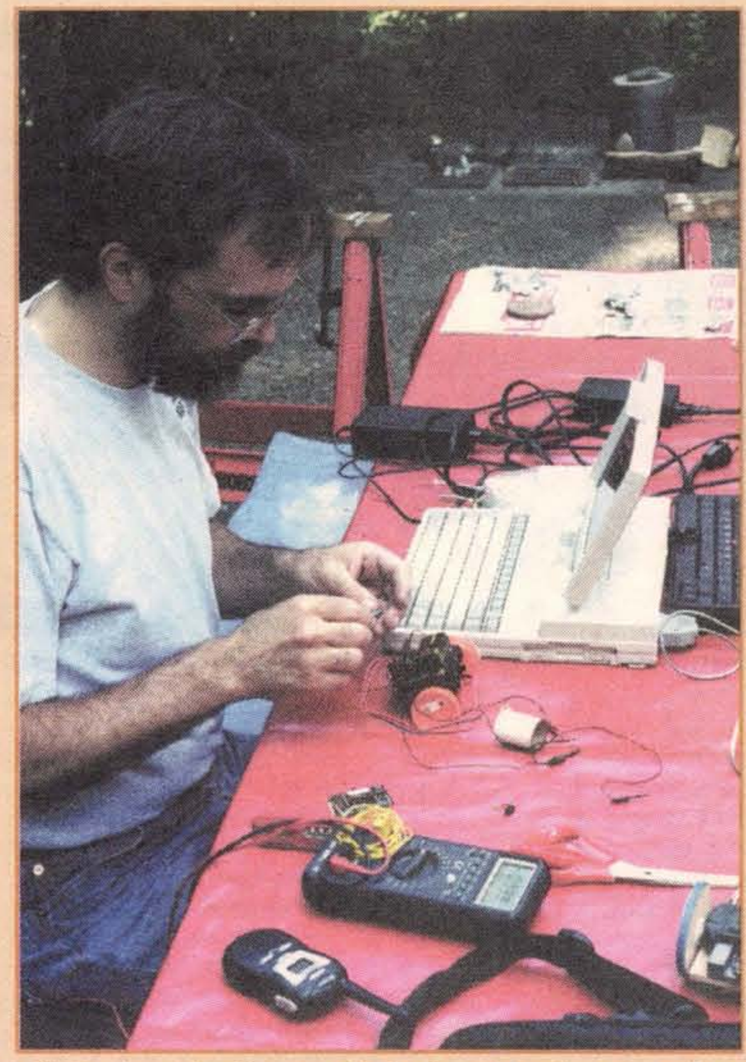
Jeff is keen on wooing amateur roboticists into using high-level languages such as C++ for their robots. With their '332 hardware, they stand a good chance, since efficient freeware compilers are readily available for the '332. With its TPU — a sort of super-duper programmable timer I/O unit — the '332 is a robot builder's dream chip, and if anything can wean us gearheads from assembly language, it's this.

I drink my beer and finish my veggie sandwich, as Jeff and the others talk about the possibilities of the



Bill and Isa demonstrating an experimental method of molding a silicone rubber tire on a robot wheel.

The drag and cope clamped together for the pour, Gene pours the molten aluminum from his miniature crane ladle. On the right is the home-made crucible furnace he used to melt the aluminum, and on the ground is the lid to the furnace. The stubby pipe projecting from the furnace is the tuyere, the air inlet to which is attached a hair dryer. The furnace burns nothing but plain old charcoal, and the whole setup is quieter and cleaner than any of the camp fires in the campground.



Bill Harrison checking out the brains of Catalina, the robot Isa and he built entirely at GEAR.

'332. Then there is a spirited discussion of the merits of machine vision systems, with Ron Nucci leading the charge for non-traditional vision. He believes we should think of video cameras more as fine-resolution sensor arrays than vision systems. He is also excited about work he's doing with RAD Robot, in particular, a sort of brain transplant board to convert a RAD from an RC toy into a serious experimental robot. I relax into the lawn chair and smile. This is the stuff I came for.

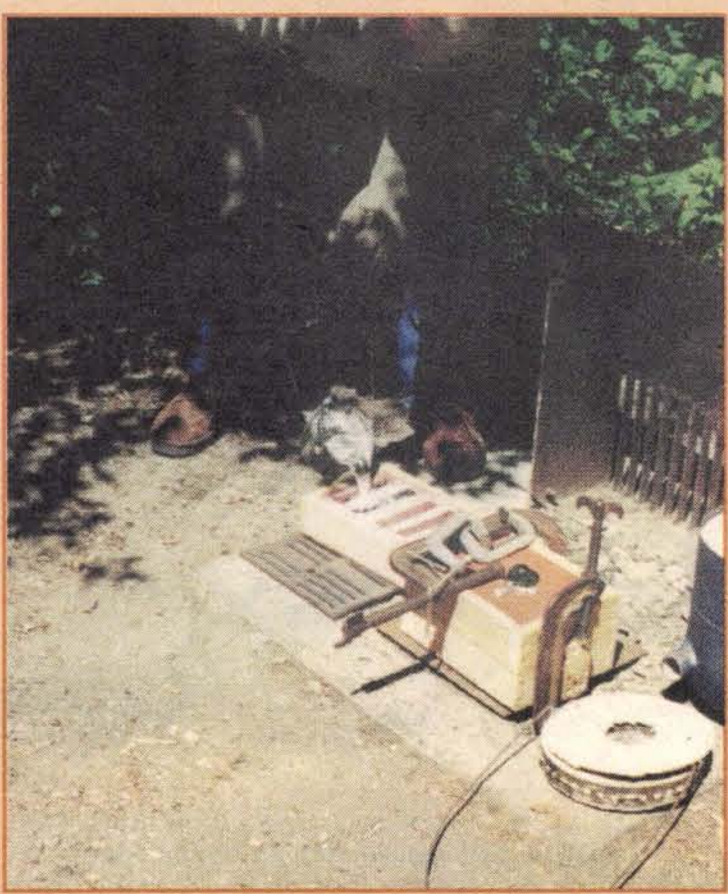
Ron and I talk into the night, long after the others have all gone to bed. As it turns out, we are both stay-at-home dads, and we both aspire to make a difference in amateur robotics. Ron tells me more about his RAD Robot plans, about a robot navigation approach using something called LPS – Local Perceptor Space. I know little about this, but it appears to be a faster and less memory-intensive way of keeping track of obstacles and landmarks than occupancy grids. In a lull in our conversation, Ron nudges one of the logs with his boot, sending a flurry of firefly sparks skyward and drawing my gaze up to the blazing stars above. Ron says, "Cool."

Demo Day

Saturday. Between them, Bill and Gene have worked out a schedule of alternating tech demonstrations throughout the day. Bill shows a simple no-solder servo hack, then Gene demonstrates how to ram up a sand mold for casting aluminum. Gene had earlier (anonymously) called park ranger Richard Ambrose to see if there would be any problem if Gene were to operate his charcoal-fired crucible furnace in the park.

This wasn't a question that had ever arisen before, but it must have given Ranger Rick nightmare visions of choking clouds of black smoke and rivers of molten metal running down the Hobbit trail, so he politely refused to allow such activity. This only means that the casting demo will be done covertly, disguised to look as innocent puttering around a campfire (of which there are many, all much smokier than Gene's demo turns out to be).

While Gene stokes the furnace, we head back to Bill's table where he has assembled the two servos he and



After filling the medallion mold, Gene pours the excess aluminum into ingot molds. "You always melt more aluminum than you need, so you gotta have someplace safe to pour what's left over."

his daughter Isa have just hacked into the beginnings of a robot. Bill has been inspired by my Jiffy design, and though he doesn't have any peanut butter jar lids, he has a whole bunch of Gator-Aid lids. He and Isa will use these – along with tape, oversized pipe cleaners, a BASIC Stamp clone, and tongue depressors – to build a robot caterpillar.

Back at Gene's campsite, the metal is hot enough to pour. The furnace is quiet, barely audible beyond the bushes shielding Gene's site from the ranger's eyes. No visible smoke. The big moment comes when Gene removes the crucible from the furnace and quickly makes his pour. In a few minutes, the casting solidifies and cools enough to shake it out the sand mold.

The petrobond sand, smokes just a little from the heat, but even this quickly dissipates. I'm impressed. This is much less work than I remembered from casting aluminum in green sand in college. I recall we spent most of our effort then getting the sand to just the right moisture content, but with the oil-based petrobond sand you just don't have to worry about this. The sand is ready to go whenever you are.

The casting turns out great. It's a commemorative medallion Gene designed especially for GEAR, and he awards it to Bill and Isa, the only ones who built a complete robot during the campout. I designed Jiffy for just this, but decided I'd have a better time talking to folks rather than building a robot, so no medallion for Jiffy.

To finish off the afternoon, Bill gives a demo of a different kind of casting process, this time with silicone rubber. He shows how to make simple, cheap robot wheels. First, you use a hole saw to cut disks of hobby shop plywood or expanded PVC (sold under the "Sintra" brand name), then you put them in home-made molds (also made of plywood) to mold silicone tires onto the rims of the disks. The process works, though some of the tires delaminate in spots. Bill goes right to work roughening up the rims of the next batch of wheels so the silicone will adhere better.

Is it Time to Eat?

More people have shown up for the traditional GEAR Saturday potluck dinner. I greet old friends from the SRS: Frank Haymes, Dick Martin, and Ron Provine, and meet a couple new people. There's a buzz about GameBoy video cameras, which are being remaindered at Toys-R-Us for $10.00.

Ron Provine shows me one he's just picked up. This coming year, there will be many more attempts at integrating video cameras with robots, to which I say, "Bully!"

Ron Provine also speaks with me of his interests in educational robots and kids. He's worked with a lot of grade school and middle school kids and is very high on Atmel processors since they give good performance and don't cost much.

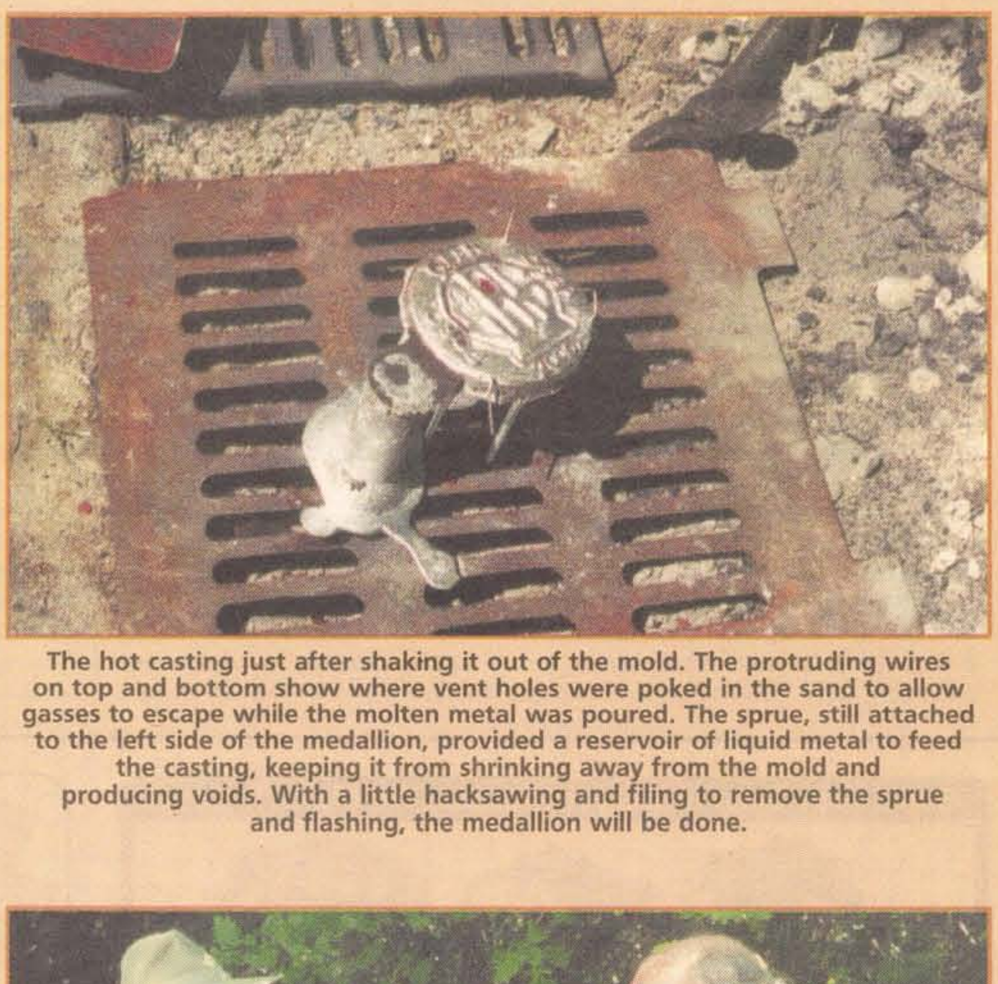
Dick Martin, when he isn't making cryptic comments about "fuzzy hypercube phase space mapping" (I'm not making this up), enthuses about the prospects of using byte-code interpreter languages like Python and jPython (Python written in Java) for robotics. I know a little about Python but haven't tried it. Dick says Python programs read more like good pseudocode than C. I figure it's worth looking at.

A couple hours before dinner, I retire to my campsite to chop onions, tomatoes, peppers, and garlic for a pot of vegetarian chili. Randy Carter shows up and we chat about his latest project, a giant scoreboard for Robot Sumo events, while I wrestle with my campstove. The stove works great for boiling water, but it appears to have only three settings: "too hot," "hotter still," and "call Gene quick, it's time to melt metal." I manage to keep the chili from scorching by turning the stove on for just a minute or so at a time (and repeating this process about 20 times).

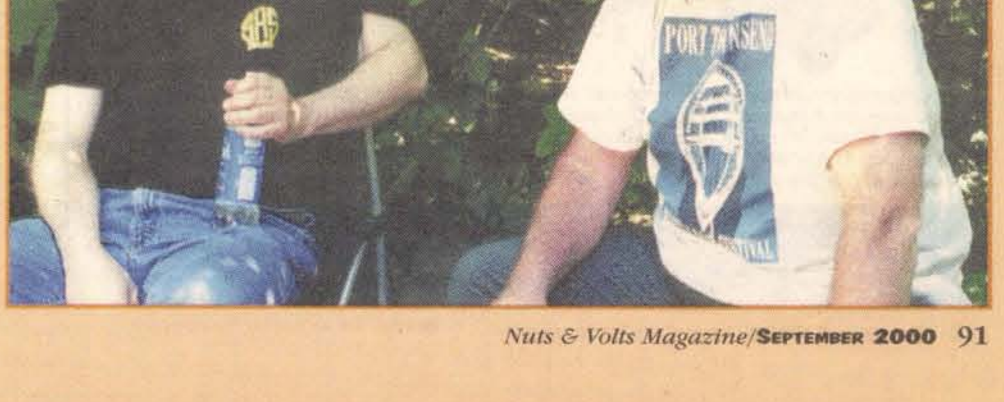
More Casting!

After dinner, Gene graciously conducts another aluminum casting demo, proving it really is as simple as it seemed the first time. While the casting cools, a group of us head down the Hobbit trail to the beach to catch sunset over Puget Sound. I bring Jiffy along so I can see how well it does on wet beach sand (no problem).

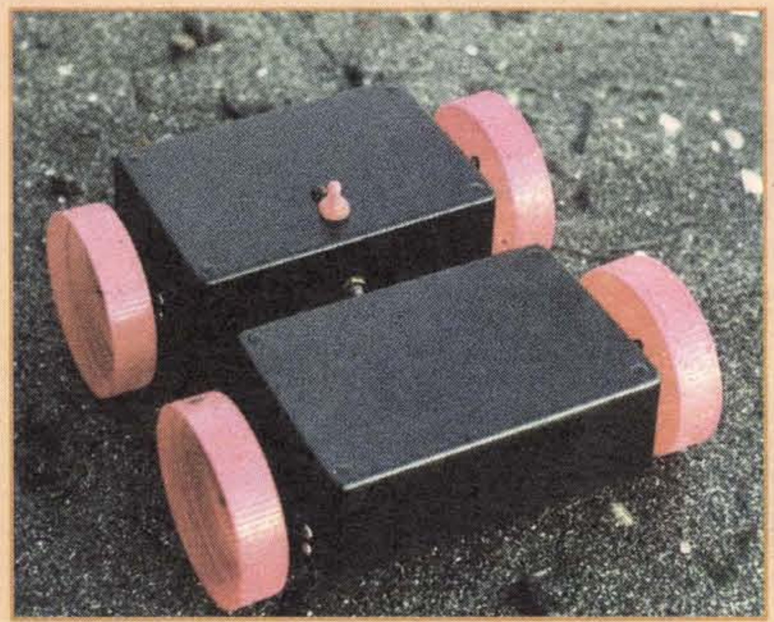
The drag has been removed, revealing a perfect casting.



The hot casting just after shaking it out of the mold. The protruding wires on top and bottom show where vent holes were poked in the sand to allow gasses to escape while the molten metal was poured. The sprue, still attached to the left side of the medallion, provided a reservoir of liquid metal to feed the casting, keeping it from shrinking away from the mold and producing voids. With a little hacksawing and filing to remove the sprue and flashing, the medallion will be done.



Dick Martin (right) discusses the finer points of "fuzzy hypercube phase space mapping" with Frank Haymes (left). I have no idea what the heck Dick was talking about, but I swear it was about fuzzy hypercubes. Or something.



Jiffy making tracks in wet sand on the beach at twilight. Just two seconds after I snapped this picture, Jiffy was nearly swamped by a wave I hadn't seen coming. I picked Jiffy up just in time.

Jiffy on the right, Catalina on the left, and the medallion Gene awarded to Bill and Isa for building Catalina in the middle. Catalina was inspired by my Jiffy design, though Bill used Gator-Aid lids for wheels instead of peanut butter jar lids. Catalina's wheels are purposely mounted off-center to make for interesting motion.

We climb back up to camp in the fading light, thankful the trail is so well marked. The second medallion turns out as perfect as the first.

The non-campers trickle away leaving us hardcore GEAR-heads to speculate around the campfire one last evening. We talk for quite a while about Disney and animatronics. I've never been to any of the Disneys, but I enjoy listening to the afficionados.

I talk some about what the writer's life is like and even a little about the novel I'm working on. As the night before, Ron Nucci and I stay up way too late. I talk a bit about nanotechnology (one of my interests) and Ron tells me more about LPS.

Toward midnight, I spot a satellite crossing the sky. Ron can't see it at first, so he turns off his Coleman lantern. He spots it when I tell him it's passing between two stars immediately above the shadow of one of the giant Douglas firs that surround us. The light of the satellite pulses slowly, and I conclude it must be a spent Russian booster tumbling end-over-end.

The tumbling booster climbs higher in the sky, and just as I begin to lose track of it, a brilliant meteor streaks from east to west. Its briefly glowing trail covers a third of the sky, maybe more beyond the circle of trees, and the meteor itself goes out in a fireball, though it's much too high to make a sound. Ron and I both say, "Cool!" A good omen, we think.

Saddling Up

Sunday morning all of the tent campers (except me) pack up and are gone by 10:30. Neither Bill nor Gene are awake yet, so I have time to write a few thoughts and to miss Shoshana and Yonatan. They are supposed to rejoin me before 11 o'clock, but this supposes that Shoshana will have dragged herself out of bed at 7:30 in order to catch an early ferry.

To my delight, they show up right on time. I give them both big hugs and kisses, and tell them about the amazing experiences of the last two days. About this time Bill and Isa are up, then Gene. Gene tells me that he hopes we all do GEAR again next year.

He'd like to see the SRS come up with more contests where the emphasis is on writing software for a common robot platform — racing eproms in effect, rather than motors. This is an idea I've long thought about, so maybe we can get something going.

Wrapping Up

I hope from the photos and text you get a feel for what attending a GEAR is like. Next time, I 'spose I'll just fly straight to Seattle and skip the arduous road trip. Or maybe I'll organize an Eastern GEAR more accessible to all you east-coast robot builders.

If anyone would like to set one up, particularly if you are part of an organized amateur robotics club, drop me a note, and maybe I can give a hand.

We're already planning next year's GEAR in Seattle, and if it or other regional GEAR events as may arise turn out half as well as this years, then they will be great fun indeed. **NV**

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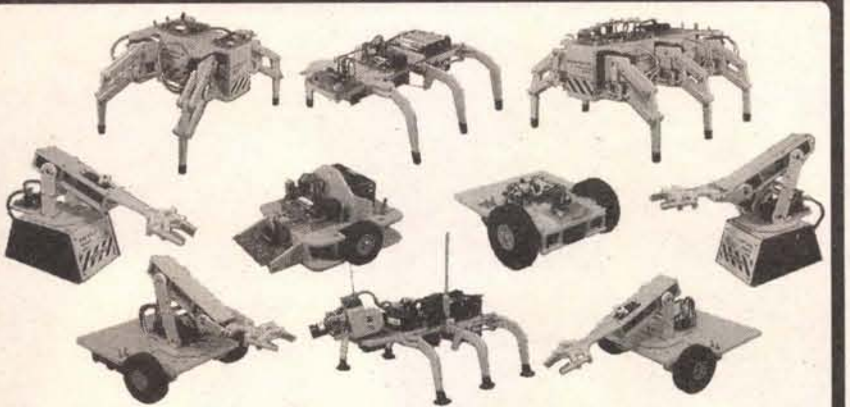

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New Product News

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EMAIL: par@parelectronics.com
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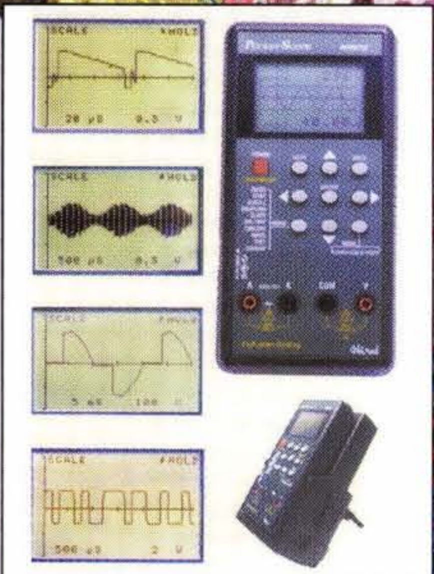
HANDHELD DIGITAL STORAGE OSCILLOSCOPE/COMPONENT CURVE TRACER

Allison Technology Corporation announces the HH972, a handheld digital storage oscilloscope and in-circuit component curve tracer. The HH972 provides two useful test instruments in one package the size and weight of a digital voltmeter and at a price more in line with that of a DVM than an oscilloscope or a component curve tracer.

Features include: oscilloscope mode, with full auto-ranging; curve tracer mode, displays I/V curves for in-circuit component testing; wide 5MHz bandwidth (digital sampling @ 20 mS/sec); lightweight, just over 12 oz.; low cost; power internal 9V battery or AC wall adapter; high contrast back-lit LCD 150 x 100 dot display with wide angle visibility; 280V true RMS AC, ±400V DC maximum input voltage; display of amplitude, time, and resistor value; easy-to-use keypad control, hold key to freeze the display; test leads included; and optional stand with rechargeable battery.

The HH972 is well-suited for a wide variety of applications. Its small size and powerful digital storage oscilloscope capabilities make it a natural choice for both bench and field service applications. Its low cost also makes it suitable for educational and hobby use.



The HH972 digital storage oscilloscope is available now for just $259.00. The optional ST972 stand with rechargeable battery is $69.00.

For more information, contact:

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"NON-CONTACT" INFRARED THERMOMETERS

Brighton Electronics, Inc., introduces their five new state-of-the-art "non-contact" infrared thermometers. These new temperature devices bring accuracy, ease-of-use, and safety to any industry.

Measurements of hot, cold, or moving objects can be taken at a safe distance. With the laser pointer, the operator is assured of precise accurate measurements in a response time of less than one second.

The SIR812 and SIR815 each have laser pointers, wide temperature ranges, operation lock function, data hold function, C/F selectable function, and a belt attachable carrying case.

The SIR802 and SIR805 have all the same functions as the SIR812 and SIR815, but without the laser pointers.

The SIR10 is Brighton's "gun" style infrared "non-contact" thermometer. The SIR10 has all the same functions as the SIR815, yet has an easy-to-use grip gun-style handle, adustable emissivity, and K-type probe input compatibility.

Brighton Electronics also introduces eight high-quality drop and water resistant touch probe digital thermometers. Each thermometer has a large, easy-to-read LCD display, is compatible with most standard thermocouple and thermistor probes, and carries a three-year warranty.

Waterproof thermometers and probes, as well as Foodservice grade thermometers, are available. Thermometers come standard with data hold functions, min/max and status display functions, C/F selectable, and auto power off.

Each thermometer comes with a temperature probe, operation manual, and carrying case.

Brighton Electronics also offers seven specialty thermometers. These models include digital pocket thermometers, pocket dial thermometers, freezer/refrigerator spirit filled and dial thermometers, meat thermometers, candy/deep fry thermometers, and furnace/oven thermometers. Each thermometer is of the highest quality stainless steel and carries a one-year warranty.

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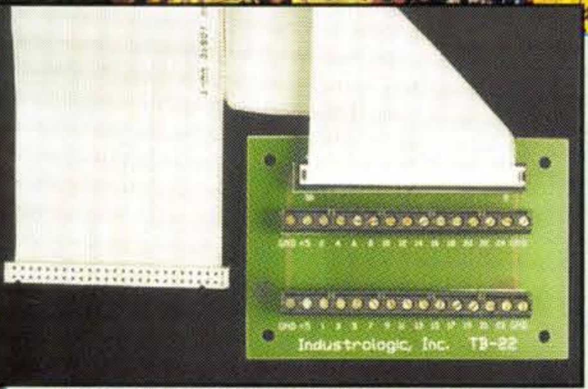

TB-22 BREAKOUT BOARD

Industrologic, Inc., announces their TB-22 50-pin header screw terminal breakout board and cable assembly.

The TB-22 is based on the Opto-22 compatible (industry standard) 50-pin header connector present on industrial digital I/O boards, and can be used to quickly and easily connect to the logic level signals present on these boards.

The TB-22 board owes its compact size to having been designed specifically for the industry standard digital I/O connections, plus its convenient 2.75 by 4 inch size and four mounting holes allows for easy panel mounting or DIN rail mounting.

Unlike most breakout boards of this style, each TB-22 comes complete with an 18-inch ribbon cable to immediately connect it to an industry standard I/O board, making the TB-22 assembly an exceptional value in a breakout board.

The TB-22 breakout board and included cable are available for $49.00 in single quantities.

For more information, contact:

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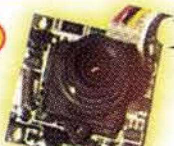

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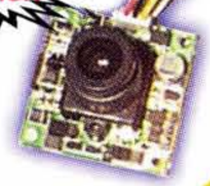

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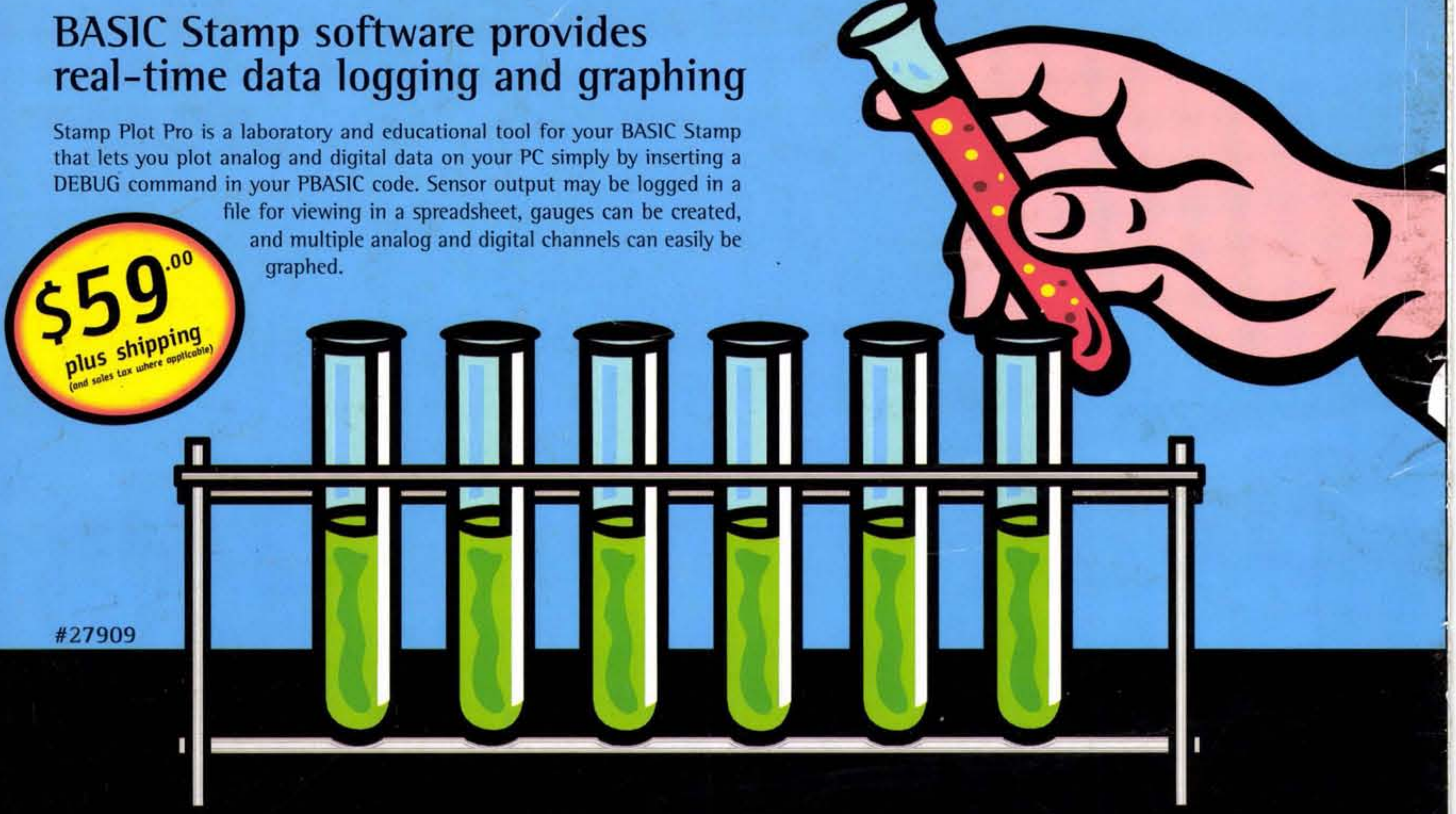

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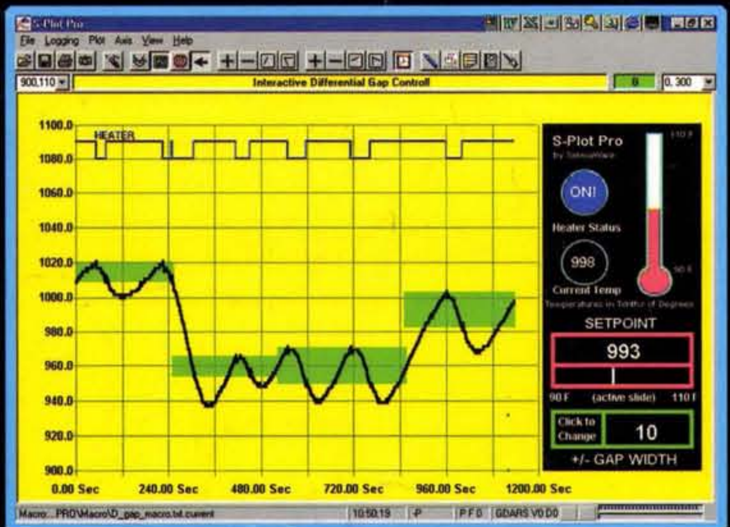

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